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***New insights into the cognitive
and functional properties of
human prospection***

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Declaration

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Maria Adriana Neroni

Abstract

A remarkable feature of the human mind is its capacity to momentarily disengage from the immediate environment in order to contemplate hypothetical future scenarios. This thesis focuses on human prospection, investigating some of the methods used to assess it, its cognitive properties and the functional relevance of this extraordinary ability to anticipate and pre-experience future contingencies. Two experiments carried out with young healthy participants show that the methods used to elicit prospection, the temporal distance and the valence of envisioned events, may affect its content as well as its characteristics. Two studies involving healthy participants of different ages as well as amnesic patients investigate the contribution of long-term memory to scene construction processes. The results provide evidence supporting the hypothesis that a common underlying memory-related factor, the capacity to construct a rich narrative, can influence the descriptions of a-temporal, future and current scenes alike. The third issue concerns the relationship between episodic future simulation and prospective memory. Five experiments with young healthy participants show that mentally pre-experiencing future contingencies associated to an intended action aids prospective remembering, over and above deep encoding processing. Overall, the results of the experiments discussed in the present thesis strengthen the view of prospection as a complex process, which, far from being encapsulated in a single cognitive function, impinges upon a constellation of constituent abilities, which may be adaptively used to anticipate and guide future behaviour.

Riassunto

L'essere umano possiede un'eccezionale capacità di distaccarsi momentaneamente dall'ambiente attuale al fine di contemplare ipotetici scenari futuri. La presente tesi analizza alcune caratteristiche di questa peculiare facoltà umana di immaginare e "pre-esperire" circostanze future, confrontando alcuni dei metodi utilizzati per studiarla ed analizzandone ulteriormente il substrato cognitivo e la rilevanza funzionale. Due esperimenti condotti su partecipanti sani hanno mostrato che il contenuto e le caratteristiche dei pensieri rivolti al futuro sono fortemente influenzati dai metodi sperimentali utilizzati per suscitargli, nonché dalla distanza temporale e dalla valenza emotiva degli eventi immaginati. Due studi che hanno coinvolto, rispettivamente, partecipanti sani di diverse età e pazienti amnesici, sono stati condotti al fine di valutare il contributo della memoria a lungo termine nella costruzione di scenari mentali. I risultati ottenuti supportano l'ipotesi secondo cui la capacità di immaginare e descrivere scenari a-temporali, futuri ed presenti è similmente condizionata dall'abilità di costruire una narrazione dettagliata. La terza tematica affrontata nella presente tesi riguarda la relazione tra la capacità di immaginare personali eventi futuri e la memoria prospettica. Cinque esperimenti condotti su partecipanti sani hanno mostrato che immaginare le circostanze future associate alla realizzazione di un'azione intenzionale facilita il ricordo prospettico e che ciò non si esaurisce in un semplice meccanismo di codifica profonda dell'azione futura da svolgere. Complessivamente, i risultati degli esperimenti discussi in questa tesi rafforzano l'ipotesi secondo cui la capacità di proiettarsi nel futuro è un'abilità complessa, che, lontano dall'essere un'unica funzione cognitiva, riflette il contributo di innumerevoli facoltà che sono utilizzate in modo adattivo per anticipare e guidare il comportamento futuro.

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Ti renderò sempre orgoglioso di me.

1 Introduction

1.1 What is prospection?

“[The brain is] a fundamentally prospective organ that is designed to use information from the past and the present to generate predictions about the future. Memory can be thought of as a tool used by the prospective brain to generate simulations of possible future events... We tend to think of memory as having primarily to do with the past... But I think the thing that has been neglected is its role in allowing us to predict and simulate the future” (Daniel Schacter, cited in Falk, 2008).

A remarkable feature of the human mind is its capacity to momentarily disengage from the immediate environment in order to contemplate hypothetical future scenarios (Suddendorf & Corballis, 1997; Wheeler, Stuss, & Tulving, 1997). This process of trying to paint a picture of the future – here referred to as prospection (e.g., Szpunar, Spreng, and Schacter, 2014) — is pervasive in daily life and serves the basis for many cognitive processes, including decision making, planning, emotion regulation and problem solving (D'Argembeau, Renaud, and Van der Linden, 2011). By simulating hypothetical future events, people can indeed mentally “test” alternative hypothetical scenarios of what might happen, imagine how selecting different actions would play out, and mentally explore different courses of actions that could be taken to attain or avoid the imagined state of affairs. Thus, the adaptive value of simulated future events mainly draws from informing anticipation and planning, while saving the costs of engaging in physical behaviour (e.g., Buckner & Carroll, 2007; Ingvar, 1979; Schacter & Addis, 2007, 2009; Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 2007, Szpunar, 2010).

The study of how humans can reach this sophisticated act of cognition has undergone a dramatic surge of research activity within the last past decade leading to a re-conceptualisation of human brain as a fundamentally prospective organ designed to

use information from the past to generate predictions about the future (Schacter, Addis, & Buckner, 2007).

Initially, researchers emphasised the importance of the episodic contribution to prospection, considering episodic memory as a fundamental part of future thinking, since it provides the “raw material” (Suddendorf, 2010, p. 100) to envisage situations likely to occur in the future. The preferential focus on episodic memory, rather than on other memory systems, such as semantic memory, seems to stem from the unique relationship that episodic memory bears with time, a relationship of which semantic memory system is devoid (Tulving, 2002, de Vito & Della Sala, 2011). Episodic memory and prospection have been in fact considered to serve as complementary functions at opposite ends of one’s temporal narrative and have been together viewed as comprising the broader faculty of mental time travel (Suddendorf & Corballis, 2007).

Subsequent considerations concerning the ability of foreseeing by reshuffling different snippets to shape novel arrangements led to the hypothesis that also processes unrelated to episodic memory play an integral role in mentally constructing future scenes (de Vito & Della Sala, 2011). Far from being an exact replication of past memories into novel contexts, future simulation is indeed the result of a constructive process driven by personal goals and future expectations. Therefore, in the attempt of gaining greater control over the simulation of scenes, a more recent branch of research has been addressing the non-episodic contributions to prospection (e.g., Rosenbaum, Gilboa, Levine, Winocur, & Moscovitch, 2009; Gaesser, Sacchetti, Addis, & Schacter, 2011; de Vito, Gamboz, Brandimonte et al., 2012). Instead of considering episodic memory as a “vocabulary” of elements on which to draw to foresee, it has been argued that episodic memory and prospection share the same neurocognitive resources. They might draw on a widespread range of specific abilities, like a particular type of consciousness (autonoetic consciousness; Tulving, 1985), the ability of binding details, executive functions, self-projection and related capacities, like conceiving others’ viewpoint (theory of mind) (Buckner & Carroll, 2007). That is, a number of cognitive functions other than episodic memory, might play an integral role when constructing scenes (de Vito & Della Sala, 2011).

A simultaneous line of research has been instead investigating the functional relevance of prospection in everyday life. Within this context, a number of evidence has increasingly showed that future simulation significantly contributes to the successful pursuit and maintenance of psychological and functional wellbeing (e.g.; Szpunar, Addis, McLelland, & Schacter, 2013, Szpunar, 2010). For instance, imagining future contingencies associated to one's possible future state may help people develop better plans leading to future goals' achievement (e.g., Taylor, Pham, Rifkin, & Armor, 1998), to identify strategies to deal with possible future problems (Sheldon, McAndrews, & Moscovitch, 2011) and to release emotional tension associated to an upcoming stressful event (e.g., Brown, MacLeod, Tata, & Goddard, 2002). Thus, a comprehensive understanding of human prospection requires to expand the investigation beyond the cognitive processes underpinning this ability to also explore the functional benefits which may arise from future simulation in everyday life.

The present thesis aims at investigating the cognitive and functional properties of human prospection in order to develop a better understanding of the mechanisms underpinning this ability and the functions that it serves. Accordingly, it will first provide a critical review of the current knowledge regarding this fundamental mental ability.

1.2 The episodic contribution to future-oriented cognition

Although prospection is a unique faculty, originally the concept was extensively discussed in relation with episodic memory. Consequently, for most of the past decade, such terms as 'episodic future thought', 'episodic simulation/construction', 'episodic self-projection', and 'episodic foresight' became the *lingua franca* of the field (Klein, 2013).

Selective impairments in prospection observed in case studies of amnesia provided preliminary evidence supporting the idea that being able to access details from episodic memory may be an important and perhaps necessary condition for

successful construction of episodic simulations. For instance, K.C., a patient with dense autobiographical amnesia resulting from a head injury, showed difficulties in imagining his personal future that mirrored his inability to remember his personal past (Tulving, 1985). Similarly, patient D.B., who sustained brain damage as a result of cardiac arrest and anoxia, could not remember or imagine personal events (Klein, Loftus, & Kihlstrom, 2002). Although no formal study was published investigating the ability to imagine fictitious events of the famous amnesic patient H.M., anecdotal evidence suggests that his ability to predict his personal future was impaired. When, in 1992, he was asked what he believed he would do tomorrow, he replied: “whatever is beneficial” and appeared to have “no database to consult when asked what he would do the next day, week, or in years to come” (S. Corkin, personal communication; cited in de Vito & Della Sala, 2011).

Similar to those suffering from amnesia, coexisting episodic memory and prospection impairments were then reported in patients with Alzheimer’s Disease (Addis, Sacchetti, Ally, Budson, & Schacter, 2009), Mild Cognitive Impairment (Gamboz, de Vito, Brandimonte, Pappalardo, Galeone, Iavarone, & Della Sala, 2010), chronic depression (e.g., MacLeod & Salaminiou, 2001), schizophrenia (D’Argembeau, Raffard, & Van der Linden, 2008), autistic spectrum disorder (e.g., Lind & Bowler, 2010), and post-traumatic stress disorder (e.g., Brown, Addis, Romano, Marmar, Bryant, Hirst, & Schacter, 2014).

Developmental research also contributed to corroborate the idea that prospection critically depends on episodic memory. Briefly, older adults and children under the age of about four — characterized by impaired and underdeveloped episodic memory, respectively — show parallel difficulties in remembering specific past episodes and in simulating detailed mental representations of future events (Addis, Wong, & Schacter, 2008; Atance & O’Neill, 2005; Busby & Suddendorf, 2005; for reviews Szpunar & McDermott, 2008b, 2008c).

Consistent with these considerations, a number of cognitive studies revealed that episodic memory and prospection are similarly affected by a number of experimental manipulations. For instance, the valence and temporal distance of both past and future events similarly influence the subjective aspects of the mental representations

of those events, with positive and temporally close events being more richly remembered or imagined as compared to negative and distant events (D'Argembeau & Van der Linden, 2004). Moreover, individual differences in emotion regulation strategies and imagery (D'Argembeau & Van der Linden, 2006) similarly affect the phenomenological characteristics associated to either past or future representations.

This converging evidence was strengthened by a number of neuroimaging results revealing that a common neural network, encompassing specifically the medial prefrontal cortex, the posterior regions in the medial and lateral parietal cortex, the lateral temporal cortex, and the medial temporal lobe including the hippocampus (Okuda, Fujii, Ohtake et al., 2003; Addis, Wong, & Schacter, 2007; Szpunar, Watson, & McDermott, 2007), is similarly engaged when people remember specific past events and imagine specific future events (for reviews, Buckner & Carroll, 2007; Schacter, Addis, Hassabis, Martin, Spreng, & Szpunar, 2012; Szpunar, 2010).

Overall, these findings gave rise to a number of theoretical proposals, which explicitly linked aspects of past and future oriented thinking at the cognitive level (e.g., Suddendorf & Corballis, 2007; Wheeler, Stuss, & Tulving, 1997). A particularly influential theory —*the constructive episodic simulation hypothesis*— maintains that episodic memory supports the construction of future events by extracting and flexibly recombining stored information into a simulation of a novel event (Schacter & Addis, 2007, 2009). Thus, both episodic memory and prospection are thought to involve constructive processes, although future thought requires greater flexibility, given that there are no constraints on the possible combinations of features included in the event representation (in contrast, episodic memory is constrained by the specific combination of features present at encoding). This is the reason why future oriented thought tends to elicit increased neural activity relative to remembering, potentially reflecting the increased cognitive demands of flexibly recombining multiple past episodes in generating a novel simulation of a future event (Addis et al., 2007; Okuda et al., 2003; Szpunar et al., 2007).

Prospection is, in fact, more an act of construction based on past instances than a simple “projection of past trends” (Haith, 1998). As Kassam, Gilbert, Boston, and Wilson (2008) surmised: “representations of past and future events are not like two

photographs with different time stamps, but rather, they are like two photographs taken from different angles with different lenses and different settings” (p. 1553). Therefore, although extracting details from personal past experiences is certainly an essential ingredient for imagining future events, episodic memory may be not the only cognitive function that people use when foreseeing personal future events.

1.3 Beyond the episodic contribution to prospection

Although there is a substantial amount of similarities between remembering episodic memories and imagining future events, it has been recently suggested that “episodic memory may not be a *condicio sine qua non* in simulations of future scenarios” (de Vito & Della Sala, 2011, p. 7). Such an intuition has been corroborated by a number of recent experimental findings that could not be adequately subsumed under models that exclusively emphasized the role of episodic memory in building future simulations (Irish, Addis, Hodges, & Piguet, 2012).

A crucial caveat to the hypothesis that the two time-related functions might be closely interconnected is that a number of amnesiacs show preserved ability to perform prospection tasks. For instance, spared prospection capacities in a context of amnesia have been observed in five amnesic patients whose performance fell within, or even above, the control range (Squire, van der Host, McDuff et al., 2010), in the single-case of Jon, with developmental amnesia (Maguire, Vargha-Khadem, & Hassabis, 2010), in group of twenty-one children with a bilateral hippocampal damage (Cooper, Vargha-Khadem, Gadian, & Maguire, 2011), and in P2, one of the patients examined by Hassabis and colleagues (2007). A first explanation proposed in the attempt of explaining these results assumes that, at least in some occasions, patients with episodic amnesia may be able to complete prospection tasks by relying on generalized memory for routine events or well-established scripts in semantic memory, which do not place demands on episodic memory (e.g., Maguire et al., 2010; Cooper et al., 2011; Maguire & Hassabis, 2011; Race, Keane, & Verfaellie, 2013). Indeed, although amnesic patients have deficits in imagining their future

experiences, they maintain the ability to imagine future public events and general facts that might be true at a future time (e.g., Klein et al., 2002).

Research on cognitive ageing also supports this view by suggesting that, when faced with reduced or no access to episodic memory, it may be a natural compensation strategy to rely on semantic information in order to aid future projection. There is, in fact, much evidence that older adults tend to provide more “gist-like” and semantic descriptions of future events as compared to their younger counterparts (e.g., Addis et al., 2008).

In light of these findings, the recently proposed ‘semantic scaffolding hypothesis’ is particularly pertinent, whereby semantic knowledge appears to provide a framework, or scaffolding, which facilitates past retrieval and future thinking (Greenberg & Verfaellie, 2010; Irish et al., 2012). Consistent with this view, investigations on patients suffering from semantic dementia (with corresponding impairment of semantic memory) showed that they had difficulty in constructing novel future scenarios, despite largely intact episodic function (Irish et al., 2012). The ‘semantic scaffolding hypothesis’ received additional support from recent cognitive studies on healthy individuals revealing that general or semantic personal knowledge guides the retrieval of episodic details during the construction of future events, providing a basis for structuring and interpreting them (D’Argembeau & Mathy, 2011; D’Argembeau & Demblon, 2012; Klein, 2013).

However, although preserved general conceptual knowledge in amnesia may support prospection to a limited extent, this knowledge is not sufficient to allow the construction of detailed and specific future representation (Race et al., 2013).

Accessing past memories of similar experiences is, indeed, only a starting point in the process of future simulation. Once this information has been retrieved, it still has to be used in a meaningful way to construct a novel and plausible future representation. This process requires scene and narrative construction processes (e.g., Hassabis et al., 2007; Romero & Moscovitch, 2012; Zeman, Beschin, Dewar, & Della Sala, 2013) and involves an interaction of different functions that play crucial roles

in producing, flexibly combining and integrating the available details into a coherent whole.

Deficits or decline of this mechanism might account for impairments in a wide range of conditions. For instance, difficulties in the ability to retain and assemble disparate details into a unique scene might explain why patients with episodic amnesia show difficulties even in imagining spatially coherent events involving commonplace scenes which are not temporally organized (i.e., imagine a day on a tropical beach, Hassabis et al., 2007) as well as in retelling semantic narratives of fairy tales and bible stories that are impersonal and not necessarily temporally dated (Rosenbaum et al., 2009).

These and related observations have recently led some investigators to propose that the capacity to construct an imagine future scenario can be affected by different basic and dissociable processes that might have been confounded with each other in previous work, and only some of which appear to depend on the ability to mentally travel through time (Kwan, Craver, Green, Myerson, & Rosenbaum, 2013).

This view has recently received support from studies revealing that deficits/difficulties in past and future thinking previously documented in amnesic patients and healthy elderly people also extend to description tasks that do not require a capacity to locate oneself backward or forward in time (for instance, when participants are required to describe an environment or a picture, Gaesser et al., 2011; Zeman et al., 2013).

Taken together, these observations highlight the need to fractionate prospection into distinct underlying components, in order to fully understand the cognitive underpinnings of this extraordinary ability to anticipate and mentally simulate future contingencies.

1.4 The functional relevance of prospection

“What is the benefit of knowing what has happened in the past? Why do you care? The importance is that you’ve learned a lesson [...]. Perhaps the evolutionary advantage has to do with the future rather than the past.” (Folk, 2008).

Fueled by a combination of personal recollections and semantic knowledge (e.g., Addis et al., 2007, Buckner & Carroll, 2007, Szpunar, 2010), prospection is an important tool for navigating the complexity of everyday life. Much of human mental life and its cultural products — norms, written and material resources, symbolic representation, science, religion — derive from our capacity to orient toward, and plan with respect to, an uncertain but potentially controllable future (Klein, 2013). Through the ability to preview the future, people can anticipate how best to think, feel and act in just about any conceivable setting (Gilbert & Wilson, 2007, 2009; Suddendorf & Corballis, 2007). Thus, imagining hypothetical future events can be used to inform prediction and planning while saving the costs of engaging in physical behaviour. This is clearly illustrated by research on “time perspective”, which convincingly demonstrated that adopting a future orientation is associated with many positive consequences, including higher socioeconomic status, superior academic achievement, and fewer health risk behaviours (e.g., Zimbardo, Keough, & Boyd, 1997; Zaleski, 1994).

A number of evidence increasingly shows that the capacity to shape and direct our future behaviour may significantly contribute to the successful pursuit and maintenance of psychological and functional wellbeing. For college students, imagining the steps they need to take to pass an impending exam can help them better prepare for — and perform on — the exam (Taylor et al. 1998). Older adults, who report fewer episodic details for imagined future events than young adults, also produce fewer means of effectively solving everyday problems (e.g., moving into a new neighborhood, finding a lost watch; Sheldon et al., 2011). Imagining future events has even been shown to promote less impulsive and more farsighted decision-making. For instance, imagining to receive a reward in the future attenuated a bias

toward selecting more immediate but less valuable rewards, in contrast to merely viewing the reward amount (Peters & Büchel, 2010), or generating semantic estimates of what the reward could be used to purchase (Benoit, Gilbert, & Burgess, 2011). Furthermore, simulating positive hypothetical scenarios may temporarily release emotional tension associated to an upcoming stressful event and motivate towards a successful resolution (e.g., Brown et al., 2002). This may be the case with “partners in a troubled relationship who imagine that they will be happy in the future as a means of diffusing emotional tension” (Szpunar, 2010).

Although there exist many instances in which simulating a hypothetical future episode may provide a functional benefit to behaviour, not all of them require to think about the future in a specific way (Szpunar, 2010). As maintained by Suddendorf and Corballis (2007), “future-oriented behaviour may not always be based on the individual representing a temporally and contextually displaced event, just as mental time travel may not always manifest in future-oriented behaviour”.

In some cases, it is sufficient to access general autobiographical knowledge about one’s future without imagining any specific scenario (e.g., to keep track of one’s own goals and set priorities among potentially competing goals, Szpunar, 2010). In other instances, it is undoubtedly useful to envision specific aspects of an upcoming event (e.g., to plan concrete actions and successfully carry out one’s intentions; Gollwitzer, 1999). To this regards, a particularly interesting example can be provided by the concept of “episodic intention” which has recently referred to as “the mental act of setting a goal in relation to a specific autobiographical future event” (Szpunar et al., 2014, p. 5). This concept seems to imply a close relationship between episodic future thinking (EFT, an “episodic” form of prospection referring to the simulation of a temporally and contextually specific future event, Atance & O’ Neil, 2001) and another well-known future-oriented process, prospective memory.

Prospective memory (PM) refers to the ability to remember to perform planned actions in the future (e.g., Brandimonte, Einstein, & McDaniel, 1996). Everyday examples of PM include remembering to buy bread on the way home from work, remembering to give friends a message upon next encountering them, and remembering to take medication after having breakfast. It is well known that PM

involves at least three distinct processes, i.e., forming an intention, maintaining the intention, and remembering at some future point to execute the intention (e.g., Brandimonte et al., 1996). The mechanisms and characteristics of this multi-component cognitive function have been extensively investigated in the last decades, mainly focusing on characterizing the differences among various types of prospective memory tasks, the properties of cues that trigger recall of intentions and the processes involved in monitoring whether an action needs to be performed (e.g., Brandimonte et al., 1996; Einstein & McDaniel 2005; Dismukes, 2010; Kliegel et al., 2008). Yet, with very few exceptions (Nigro et al., 2013), the relationship between prospective memory and prospection has been largely neglected.

As recently stated by Schacter, Addis and Buckner (2008) and Szpunar (2010), although a mental simulation of the future need not necessarily accompany the formation of an intention, there is reason to believe that EFT may come into play in PM tasks. For instance, a sub-field of PM research, namely the study of implementation intentions, revealed that anticipating *when*, *where* and *how* an intention will be realized enhances PM performance (Gollwitzer, 1993, 1996, 1999). Along similar lines, more recent studies have shown that mentally simulating at encoding the future context in which an intention will be fulfilled significantly improves prospective remembering (e.g., Brewer, Knight, Thadeus Meeks, & Marsh, 2011; Paraskevaides, Morgan, Leitz, Bisby, Rendell, & Curran, 2010).

Although these initial findings suggest interesting avenues for the investigation of the potential relationship between prospection and PM, as they stand, they are inconclusive as to the specific role that future simulation plays in prospective remembering.

1.5 Investigating new issues concerning the cognitive and functional properties of human prospection

What emerges from the literature reviewed above is that prospection is a costly process, which impinges upon a constellation of constituent abilities, which can be adaptively used to anticipate and guide future-oriented behaviour.

In particular, prospection seems to involve at least three main processes. First, information from either specific or more general memories of similar experiences must be accessed. Second, these details need to be recombined and integrated into an organized representation in order imbue a simulation with a sense of coherence. Third, the results of this process have to be successfully encoded into memory and adapted for future use.

This thesis aims at specifically investigating each of these processes in the attempt to provide a deeper understanding of the cognitive and functional properties of human prospection.

In its First Part, this dissertation focuses on the multifaceted nature of prospection which, far from being as a monolithic entity, can be fractionated into a variety of future experiences whose representational format may be influenced by the information that is used to furnish the future simulation.

The initial emphasis on the episodic contribution to future-oriented cognition has strongly influenced not only the actual theorization on prospection, but even the way in which it has been mainly studied. Indeed, to date, most research focused on just a particular form of prospection mirroring episodic memory and referring to the simulation of temporally and contextually specific future events (i.e., episodic future thinking, EFT, Szpunar, 2010).

However, as in the case of autobiographical memories (Conway & Pleydell- Pearce, 2000), people may have conceptual knowledge about their future (e.g., expected

lifetime periods, knowledge of goals, cultural shared life-scripts) that can be accessed without necessarily generating mental representations of specific episodes. And, in fact, a considerable number of future simulations experienced by people in their daily life consists of abstract representations rather than specific, episodic events (D'Argembeau et al., 2011).

With the aim of providing a more comprehensive view on both the characteristics of prospection and the representational structures underlying this ability, Chapters 2 and 3 investigated the role of different factors, such as the method used to elicit prospection and the valence of future events, in shaping various future events having different representational format and reflecting the contribution of different types of memory and visual imagery processes.

The Second Part of this thesis aims at shedding additional light on the constructive processes underlying the simulation of future events.

As previously discussed, accessing information from memories of similar experiences is only a starting point in the process of simulating possible future events. Once these details have been retrieved, they still need to be used in a meaningful way to construct a novel and detailed future representation (e.g., Addis et al., 2007). This process requires high-order mechanisms supporting scene and narrative construction whose contribution may be, at least in part, independent from the ability to anticipate possible future contingencies (e.g., Gaesser et al., 2011; Zeman et al., 2013).

Chapters 4 and 5 discuss a series of studies aiming at elucidating the role of scene and narrative construction processes in the experimental paradigms typically used to study prospection, in both healthy subjects of different ages and in patients with memory disorders. In particular, these studies evaluate to what extent previously reported age-related and pathological difficulties in prospection abilities may be accounted for by impairments in scene and narrative construction processes.

The Third Part of this dissertation aims at providing new insights into the functional relevance of prospection by investigating some of the benefits that may arise from engaging in future simulation in everyday life.

As discussed above, far more being a mere contemplation of possible future contingencies, prospection is an adaptive process which allows people to mentally “pre-experience” what may happen in the future and plan for future contingencies that transcend their current needs and motivational states. Research showed, indeed, that prospection is a frequently occurring mental phenomenon and supports a range of everyday functions and behaviours (e.g., D’Argembeau et al., 2011). In particular, it has been recently suggested that one of the primary functions of imagining specific future events is to implement mental simulations of action plans leading to goal attainment (i.e., how to perform a future action, D’Argembeau et al., 2011). This seems to imply a close relationship between EFT (i.e., a particular form of prospection referring to the simulation of temporally and contextually specific events) and PM. Nevertheless, to date, this possibility has been almost given for granted and not fully investigated.

In order to overcome this shortcoming, Chapters 6 and 7 present a set of studies aiming at exploring whether simulating possible future contingencies associated to one’s future action improves the recollection and execution of an intended action and to what extent this facilitating effect depends on simulating the specific future scenario in which the prospective action will be executed.

In the Conclusion section, the present thesis discusses the main results arising from the bulk of extant studies in the light of the most recent theorization on human prospection.

First Part

On the multifaceted nature of human prospection

For most of the past decade, a consistent body of literature has emphasized the importance of the episodic contribution to mental simulations of the future. Episodic memory has been thought to play a crucial role in prospection, since it provides the “raw material” to shape potential future scenarios (de Vito & Della Sala, 2011).

However, recent evidence suggests that, when projecting themselves into future personal circumstances, people rely on disparate cognitive processes, which cannot be solely identified in episodic memory (e.g., D’Argembeau & Demblon, 2012). Far from being exact replications of past memories into novel contexts, future simulations are the result of a constructive process driven by personal goals and expectations. In fact, prospection is not a “one-dimensional tool but it is a dynamic, interactive process” (Christian, Miles, Fung, Best, & Macrae, 2013), which may unfold in a variety of representational formats and serve a heterogeneous range of functions (e.g., D’Argembeau, Renaud, & Van der Linden, 2011; Szpunar, 2010).

For instance, future simulation may be more or less abstract depending on personal purposes. On one hand, it may be undoubtedly useful to envision specific aspects of an upcoming event to plan and successfully carry out actions (Gollwitzer, 1999). On the other hand, people may be prone to access a general knowledge about their own future (e.g., expected lifetime periods, knowledge of goals, cultural shared life-scripts) not involving the generation of detailed mental representations (D’Argembeau et al., 2011). Indeed, a relevant amount of future simulations experienced in daily life consists of abstract representations rather than specific events (D’Argembeau et al., 2011).

Furthermore, it has been observed that the emotional valence of future events may play a critical role in affecting crucial aspects of future simulations. In particular, prospection seems to be guided by “unrealistic positive illusions” (i.e., unrealistically positive self-evaluations, an exaggerated feeling of control, and an unrealistic

optimism about the future; Berntsen & Bohn, 2010), leading people to predict that positive future events (e.g., having a good job, owning their own home) are more likely to occur than their negative counterparts (e.g., being fired from a job, divorce; Newby-Clark & Ross, 2003). Moreover, people are faster when producing positive if compared to negative future events (Newby-Clark & Ross, 2003). In addition, representations of positive future events are usually richer in details and associated with a stronger feeling of pre-experiencing than representations of negative future events (D'Argembeau & Van der Linden 2004).

Therefore, far from being a monolithic entity, prospection may be fractionated into a variety of future experiences that may reflect the contribution of different representational structures (not necessarily episodic in nature) and visual imagery processes.

Aiming at shedding additional light on the multifaceted nature of human prospection, the First Part of the thesis investigates whether the method used to elicit prospection and the valence of future events may shape different forms of future projection.

Chapter 2 explores the effect of different verbal cues in influencing the characteristics of prospection by systematically comparing future events prompted with the commonly used cueing technique (e.g. Spzunar, 2010; i.e., experimenter-provided cues) and elicited by means of verbal cues that were spontaneously generated by participants (i.e., self-generated cues), in terms of their quality, phenomenal characteristics, content and temporal distribution.

Chapter 3 discusses the results of a study aiming at investigating whether the emotional valence of simulated future experiences may influence the underlying cognitive processes. To this aim, desirable and undesirable future events were systematically compared in terms of their quality, phenomenal characteristics, accessibility and content..

2 Effects of self-generated vs. experimenter-provided cues on the representation of future events¹

2.1 Introduction

As discussed in Introduction, in recent years, the ability of simulating personal future episodes (episodic future thinking, EFT, Atance & O'Neill, 2001; de Vito & Della Sala, 2011) has attracted an impressive surge of research activity. Most experimental studies of EFT (e.g., de Vito, Gamboz, & Brandimonte, 2012; Szpunar & McDermott, 2007, 2008) used modified versions of the cueing technique (Crovitz & Schiffman, 1974; Galton, 1883), prompting participants with verbal cues to imagine personal future scenarios. These verbal cues varied from generic single cue-words (e.g., Kwan, Carson, Addis, & Rosenbaum, 2010; Squire et al., 2010) to more specific short verbal sentences depicting particular settings (e.g., "Imagine a possible future meeting with a friend"; Hassabis et al., 2007) or templates (e.g., "Imagine catching your grandchild into trouble twenty years from now"; Race et al., 2011).

Although the cueing technique has been widely used to experimentally study humans' ability to imagine personal future scenarios, there is evidence suggesting that future events differ considerably according to whether they are elicited by means of external, experimenter-provided cues or they are self-generated. For instance, D'Argembeau and colleagues (2011) showed that at least 50% of daily experienced future-oriented thoughts consist of abstract representations. In that diarist study, the authors observed that, in daily life, people frequently access conceptual knowledge regarding their personal future rather than constructing mental representations of specific episodes. Thus, future events that are commonly experienced may not be necessarily episodic in nature.

¹ Neroni M.A., Gamboz N., de Vito S., & Brandimonte M.A..(2014) Effects of self-generated vs. experimenter-provided cues on the representation of future events. *The Quarterly Journal of Experimental Psychology*. Ahead of print.

Another variable that distinguishes self-generated future events and future events produced in response to experimenter-provided cues is the presence of personal goals. In everyday life, personal goals frequently motivate mental time travel into the future to pre-experience the unfolding of an event, whereas, in experimental settings, participants are less motivated to foresight and are, therefore, more prone to rely, more or less deliberately, on few shortcuts. Indeed, Gamboz, Brandimonte, and de Vito (2010) showed that participants may retrieve, at least occasionally, events that have already taken place in the past, and adjust them to fit in with the test requirements, rather than producing genuine future scenarios.

Overall, this set of evidence seems to suggest that future representations elicited by means of experimenter-provided cues are only one type of future events that people may foresee in their daily life (e.g. D'Argembeau et al., 2011).

The present study aimed at investigating whether and, if so, to what extent, future events produced in response to experimenter-provided cues differ from future representations elicited by means of self-generated cues. Accordingly, these two forms of simulations were systematically compared with respect to their quality (i.e., amount of internal and external details), phenomenal characteristics, temporal distribution, and thematic content.

Experimenter-provided cues consisted of single cue-words (e.g., Addis, et al., 2007; de Vito et al., 2012; Szpunar & McDermott, 2007, 2008) and short verbal sentences (Hassabis et al., 2007; Race et al., 2011), most often used to study episodic future thinking. Self-generated cues were obtained through an adapted version of the Autobiographical Fluency Task (MacLeod & Byrne, 1996; MacLeod & Conway, 2007), in which participants were asked to list, in two minutes time, as many autobiographical future events as possible that might happen to them in the future, using short distinctive labels.

In previous work, the Autobiographical Fluency Task has been found to be effective in eliciting personally relevant responses (MacLeod & Byrne, 1996) and in inducing people to access immediate and realistic representations of past and future events (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010). Accordingly, it was

assumed that this task might be a useful method to obtain a list of self-generated cues, which may then be used to prompt a more genuine and realistic form of future thinking in the experimental setting.

The Autobiographical Fluency Task was originally used to study autobiographical memory (e.g., Dritschel, Williams, Baddeley, & Nimmo-Smith, 1992). More recently, its use has been extended to the study of prospection in healthy adults (D'Argembeau et al., 2010) and in patients suffering from anxiety and depression (MacLeod, Rose, & Williams, 1993; MacLeod, & Byrne, 1996). However, in those studies, the authors counted the number of future-oriented thoughts generated over different time periods (e.g., the next year and the next 5 to 10 years), without taking into account the characteristics (i.e., the amount of internal and external details, and their phenomenal characteristics) of these representations. In addition, any comparison between future events described in response to self-generated and experimenter-provided cues was beyond the scope of those studies, hence leaving the question addressed in the present research open.

In light of recent ecological investigations revealing that, in their daily life, people more frequently access general/abstract representation of the future rather than constructing specific episodes (D'Argembeau et al., 2011), it was hypothesized that future events produced in response to self-generated cues (more genuine and not bound to specific cues and time frames) would be more likely to assume a less specific representational format compared to future events elicited by means of the experimenter-provided cues. Furthermore, if future events elicited by self-generated cues are more likely to reflect participants' personal goals and interests, they should be rated as more personally relevant than future events prompted by means of experimenter-provided cues.

Finally, if the content of prospection reflects the information that comes to mind most easily (e.g., Kahneman & Tversky, 1982; Szpunar, 2010; Tversky & Kahneman, 1973), participants should report more very near and very distant future events compared to future events located at an intermediate temporal distance from the present, regardless of the type of cue used to elicit prospection. The greater accessibility of very near and very distant future events may be due to the fact that

the former typically refer to actions and decisions already planned, thus “pre-activated” (i.e., Functional Significance, D’Argembeau et al., 2011), and the latter are more likely to reflect “semanticised” future expectations, which are the type of information that people more immediately activate when they think about their future (e.g., D’Argembeau & Demblon, 2012). Conversely, future events located at an intermediate temporal distance may appear more obscure and uncertain, hence, less accessible and more difficult to represent.

2.2 Method

2.2.1 Participants

Twenty young adults (thirteen female) from Suor Orsola Benincasa University participated in this study as volunteers. The average age and education were 25.2 (SD = 3.5) and 17.4 (SD = 1.1) years, respectively. No participant had a history of neurological or psychiatric disorders. Participants gave informed written consent prior to the commencement of the study and did not receive financial compensation for participation. The study procedure was approved by the local ethical committee and was performed in accordance with the Declaration of Helsinki.

2.2.2 Experimental Tasks

2.2.2.1 Autobiographical Fluency Task

The experimental procedure was adapted from MacLeod and Byrne (1996) and from D’Argembeau et al. (2010). The Autobiographical Fluency Task involved two phases. During the first, preliminary phase, participants were instructed to think of and briefly mention, in two minutes time, as many autobiographical future events as possible that might happen to them in the future, using short distinctive labels. It was

explained that the labels should refer to trivial or important events; they could be associated to intentional thoughts or thoughts that come spontaneously to mind; they could be related to positive, neutral or negative events; they could refer to near or to more distant future. It was stressed that participants were free to mention any label they wished (whatever their content, characteristics, temporal distance, and affective connotation). It was also specified that the labels should refer to plausible future events, given the participant's plans, and should be novel, that is, not linked to previously experienced events. After two minutes, a bell rang to indicate the end of the task. The labels generated were recorded using a digital audio-recorder for later use. The only aim of this phase was to obtain a list of self-generated cues to be used to elicit detailed future representations during the second phase of the task.

In the second phase of the task, participants were instructed to describe a specific and detailed future scenario in response to the previously listed labels (i.e., self-generated cues). To facilitate the retrieval of each specific event, participants were presented with the digital record of the short descriptions they had briefly produced before. In this phase, participants were instructed to describe each event in as much detail as possible, including such aspects as setting, objects or people present, what might happen, as well as any emotions, colors, smells, tastes, or sounds that were elicited. When necessary, some examples were provided to clarify the instructions. This second phase did not involve any time constraint.

2.2.2.2 Cueing techniques

Cue-words. The experimental procedure was adapted from D'Argembeau and Van der Linden (2004) and from Addis, Wong, and Schacter (2008). Participants were asked to mentally pre-experience three autobiographical future events, in response to three single words. For each participant, three cues were randomly selected from a larger pool including twenty words taken from the Burani, Barca, and Arduino (2001) Italian norms, and matched for word familiarity, frequency, imageability, and concreteness (see Appendix A for the complete set of words). Participants were encouraged to imagine and describe a temporally and contextually specific future

event in response to each word. They were informed that the events had to be plausible, given the participant's plans, and novel, that is, not previously experienced by the participant. Participants were further instructed that the events should be imagined in as much detail as possible, including such aspects as setting, objects or people present, what might happen, as well as any emotions, colours, smells, tastes, or sounds that were elicited. Some examples were provided to illustrate what would or would not be considered as a specific event. Participants were explicitly told not to recount an actual memory or any part of it, but rather create something new. Each word was written on cards that were presented one at a time and remained in view for the duration of the description. Participants were allowed to continue with their descriptions without interference from the examiner until they came to a natural ending point.

Short verbal sentences. The experimental procedure was adapted from Hassabis et al. (2007) and from Race et al. (2011). Participants were asked to mentally pre-experience three autobiographical future events, in response to three short verbal sentences. For each participant, the verbal sentences were randomly selected from a larger pool of twenty future-oriented sentences (see Appendix A for the complete set of sentences). Participants were instructed to vividly imagine the situation suggested by each sentence and to describe it in as much detail as possible. The remaining instructions were as those for the cue-words.

2.2.3 Procedure

Each participant was tested individually and sat facing the examiner. An initial introduction explained that they would be asked to imagine some events that might happen to them in the future, and to answer some questions about these events. Then, participants received the specific instructions for the first experimental task assigned to them. Half participants performed the Autobiographical Fluency Task first, followed by the cueing technique and the other half received the opposite sequence.

Within the cueing technique, the order of conditions (cue-words vs. short verbal sentences) was completely counterbalanced across participants.

After each event description, in each experimental task, participants were required to undergo a structured interview concerning the characteristics of the event. The examiner required participants to answer different questions concerning the feasible date of occurrence of the future event (i.e., today, tomorrow, in the next few days, next week, in the next few weeks, next month, in the next few months, next year, more than one year) and its phenomenal characteristics (i.e., quantity of details, accessibility, personal relevance, feeling of pre-experience, novelty) using a 7-point rating scale (see Appendix A). In the Autobiographical Fluency Task, participants completed the structured interview during the second phase of the task, after the description of each event produced in response to each self-generated cue.

The testing sessions were digitally recorded to enable transcription and later scoring of the participants' responses. At the end of the experiment, all participants received a quick debriefing explaining the main purpose of the study. The total testing time was about one hour.

The qualities of future events produced in response to self-generated and experimenter-provided cues were estimated using the standardized scoring procedure developed by Levine, Svoboda, Hay, Winocur and Moscovitch (2002). More precisely, for each future event produced by participants, the central event (the event discussed in most detail that occurred over a brief time-frame) was first identified. The main event was then segmented into details, i.e., unique occurrences, observations, or thoughts (which typically occur as grammatical clauses defined by a subject and predicate, such as "I dropped my sandwich"). Details were classified as internal or external, internal details being those that were specific to time and place, and considered to reflect episodic pre-experiencing, and external details being those that pertained to extraneous information that was not uniquely specific to the main event being described and not anchored to time and place. Internal details were divided into further subcategories: (a) event (happenings, people involved, actions, nature of the environment), (b) place (information about where the event occurred), (c) time (date, season, or time of day), (d) perceptual (sensory information) and (e)

emotion/thought relating to the event. External details were also subcategorized: (a) event (specific details from other incidents, from all of the above categories, external to the main event imagined), (b) semantic (general knowledge or facts, ongoing events, extended states of being), (c) repetition (unsolicited repetition of details), and (d) other (metacognitive statements, editorializing). An example of the scoring procedure can be found in Appendix B. The transcriptions were segmented into internal and external details by the experimenter and by a trained rater, who was blind to the hypotheses of the study. This rater scored events in a manner that was highly compatible with the ratings provided by the experimenter. The inter-rater reliability (r) was .87 ($p < .001$) and .85 ($p < .001$) for internal and external details, respectively.

2.3 Statistical analyses

In order to balance the number of future events elicited by self-generated and by experimenter-provided cues, only the future events described in response to the first three self-generated cues produced during the first phase of the Autobiographical Fluency Task were considered and scored. The choice to select the first three future events produced in the Autobiographical Fluency Task (rather than three randomly selected events) was motivated by the consideration that they are the most immediate (i.e., generated in response to the first three self-generated cues produced during the preliminary phase of the task) and, hence, plausibly, more representative of a genuine and spontaneous form of prospection.

In all the analyses, three future events (i.e., two events prompted by means of self-generated cues and one event produced in response to a short verbal sentence) were removed as they resembled to, or were exact repetitions of, events already described.

Differences between future events elicited by means of self-generated and experimenter-provided cues were investigated as a function of the quality (number of internal and external details), phenomenal characteristics, temporal distribution and thematic content.

First, mean numbers of internal and external details were analysed by means of a 3 (Cue: self-generated vs. cue-words vs. short verbal sentences) X 2 (Details: internal vs. external) repeated measures analysis of variance (ANOVA) in order to assess whether the amount of details (internal and external) produced by participants in describing future events was affected by the type of cue used to elicit the future projection.

Second, mean scores for the subjective ratings for richness, accessibility, relevance, feeling of pre-experiencing and novelty were analysed by means of separate repeated measures ANOVAs (one for each phenomenological characteristic) in order to examine the role of different types of cues in influencing the phenomenal characteristics of future representations.

Third, the percentages of future events produced in response to self-generated and experimenter-provided cues as a function of the temporal distance of the present were compared by means of Chi-Square tests in order to assess whether the temporal distribution of future events varied as function of the types of cue used to elicit prospection and of the temporal distance from the present.

Fourth, differences in the thematic content of future events prompted by means of self-generated and experimenter-provided cues were analysed by means of a series of Chi-Square tests in order to investigate whether the content of future thinking was influenced by the method used to elicit prospection.

2.4 Results

2.4.1 Number of internal and external details

Results showed a significant main effect of Details, $F(1, 38) = 80.34$, $\eta_p^2 = .81$, $p < .001$, indicating that, overall, participants reported more internal ($M = 10.41$, $SE = 0.81$) than external details ($M = 2.56$, $SE = 0.25$).

Additionally, there was a significant main effect of Cue-type, $F(2, 38) = 3.47$, $\eta_p^2 = .15$, $p < .05$, revealing that future events prompted by means of self-generated cues ($M = 5.65$, $SE = 0.34$) were described in overall less details than future events produced in response to short verbal sentences ($M = 7.86$, $SE = 0.9$), $t(19) = -2.18$, $\eta^2 = .2$, $p < .05$. No significant difference was observed between future events elicited by means of self-generated cues and future events prompted by cue-words ($M = 5.96$, $SE = 0.64$), $p = .94$.

Finally, there was a significant interaction between Cue-type and Details, $F(2, 38) = 4.68$, $\eta_p^2 = .20$, $p = .01$ (see Figure 2.1).

In order to better understand this interaction, two separate repeated-measure ANOVAs were conducted for internal and external details, respectively. As concerns the number of internal details, the results showed a significant main effect of Cue-type, $F(2, 38) = 4.02$, $\eta_p^2 = .17$, $p < .05$. Post hoc comparisons revealed that future events produced in response to self-generated cues ($M = 8.21$, $SE = 0.56$) contained less internal details than future events elicited by means of short verbal sentences ($M = 12.98$, $SE = 1.77$), $t(19) = -2.65$, $\eta^2 = .27$, $p < .05$. However, any significant difference between the number of internal details generated when participants described future events in response to self-generated cues and cue-words was observed ($M = 10.05$, $SE = 1.19$), $p = .15$.

As regards the number of external details, it was observed a significant main effect of Cue-type, $F(2, 38) = 4.14$, $\eta_p^2 = .18$, $p < .05$. Post hoc showed that future events prompted with self-generated cues contained more external details ($M = 3.08$, $SE = 0.37$) than future events elicited by means of cue-words ($M = 1.87$, $SE = 0.30$), $t(19) = 2.83$, $\eta^2 = .30$, $p = .01$. The difference between future events prompted by means of self-generated cues and short verbal sentences ($M = 2.74$, $SE = 0.37$) was not significant, $p = .48$.

	Self-generated cues	Cue-words	Short verbal sentences
Internal Details	8.21 (.56)	10.05 (1.19)	12.98 (1.77)
External Details	3.08 (.37)	1.87 (.3)	2.74 (.37)

Table 2.1. Mean numbers (and standard errors) of internal and external details of future events generated in response to self-generated cues, cue-words and short verbal sentences.

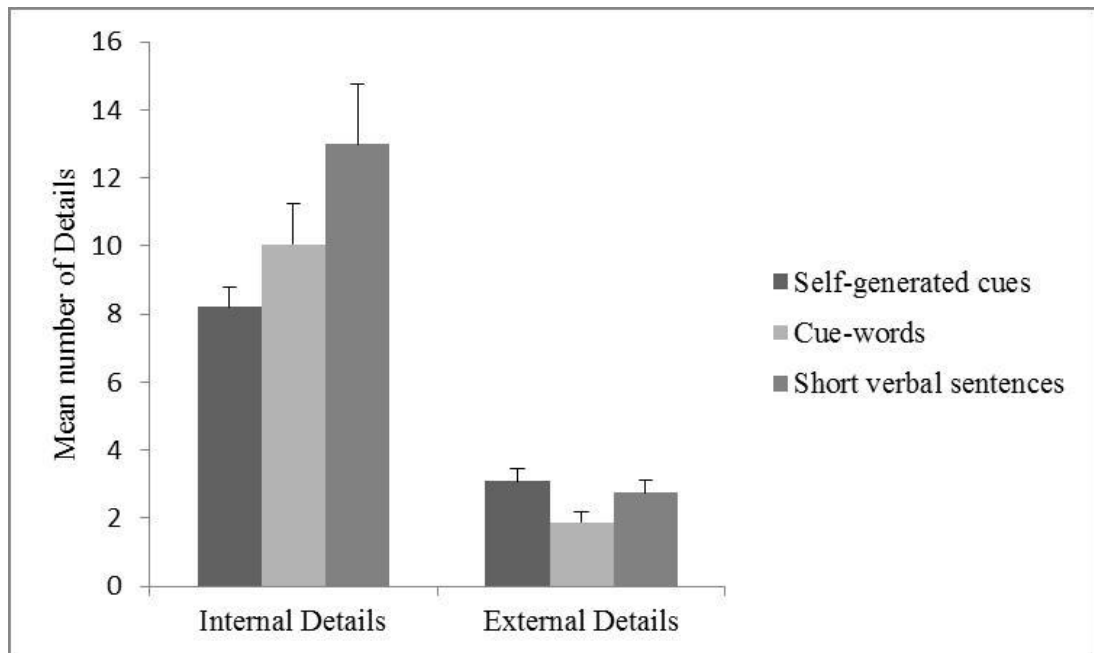


Figure 2.1. Mean number of internal and external details of future events produced in response to self-generated cues and future events prompted by means of cue-words and short verbal sentences. Error bars indicate standard errors.

2.4.2 Phenomenal Characteristics

Future events elicited by means of self-generated cues did not significantly differ from future events prompted by means of experimenter-provided cues in terms of

their perceived richness, accessibility, feeling of pre-experience and novelty, $p_s > .19$ (see Table 2.2).

	Self-generated cues	Cue-words	Short verbal sentences
Richness	5.18 (1.22)	5.08 (.87)	5.37 (.88)
Accessibility	6.01 (1.05)	5.95 (.73)	5.94 (.76)
Relevance	6.37 (.63)	4.6 (1.13)	5.7 (1.03)
Feeling of pre-experience	5.73 (1.12)	5.39 (1.22)	5.52 (.93)
Novelty	4.46 (1.72)	4.42 (1.62)	3.71 (1.9)

Table 2.2. Mean ratings (and standard error) of phenomenal characteristics of future events as a function of cue type (self-generated cues, cue-words and short verbal sentences).

As regards the personal relevance of future representations, a main effects of Cue-type, $F(2, 38) = 21.58$, $\eta_p^2 = .53$, $p < .001$, revealed that participants rated future events prompted by means of self-generated cues as more relevant ($M = 6.37$, $SE = 0.14$) than future events described in response to cue-words ($M = 4.6$, $SE = 0.25$), $t(19) = 7$, $\eta^2 = .72$, $p < .001$, and short verbal sentences ($M = 5.7$, $SE = 0.23$), $t(19) = 2.76$, $\eta^2 = .29$, $p = .01$.

2.4.3 Temporal distribution of future events

In order to assess whether the temporal distribution of future events was affected by the type of cue used to elicit prospection, the percentages of future events prompted by means of self-generated and experimenter-provided cues were compared as function of the temporal distance from the present.

	Self-generated cues	Cue-words	Short verbal sentences
Today	28.33	12.28	5.36
Tomorrow	16.67	8.77	0
In the next few days	16.67	12.28	3.57
Next week	3.33	1.75	1.78
In the next few weeks	0	0	1.78
Next month	1.67	3.51	10.71
In the next few months	3.33	15.79	17.86
Next year	3.33	12.28	25
More than one year	16.67	33.33	33.93

Table 2.3. Percentages of future thoughts reported in each experimental task as a function of temporal distance.

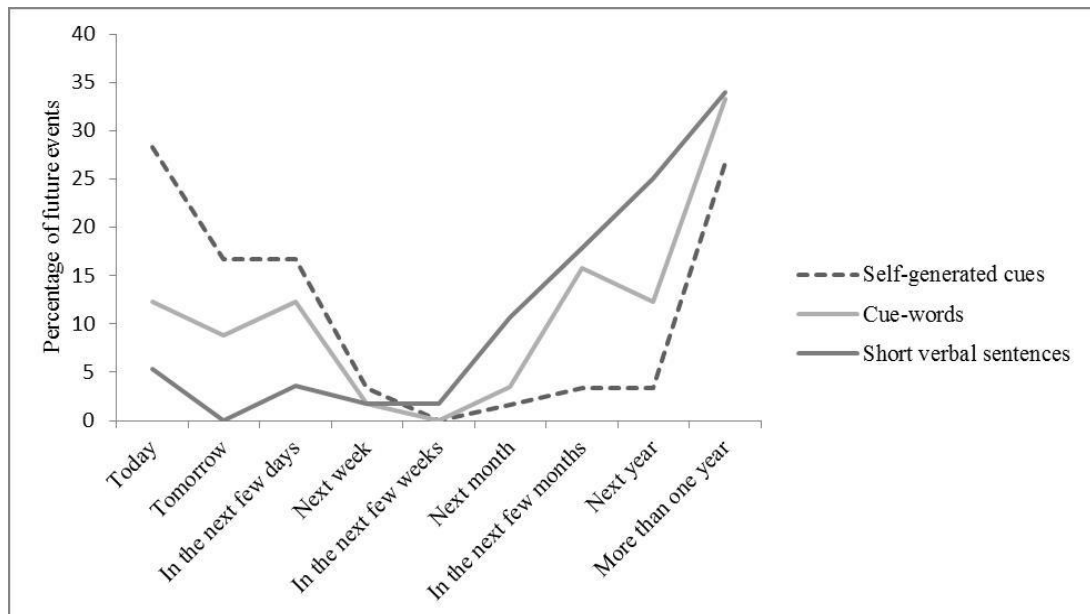


Figure 2.2. Percentages of future events produced in response to self-generated and experimenter-provided cues (cue words and short verbal sentences) as a function of temporal distance.

As indicated in Table 2.3 and in Figure 2.2, future events were not homogeneously distributed across time periods, $\chi^2(16) = 48.74$, $p < .001$. It is relevant that, overall, 31.21 % of the total of future events produced by the participants were rated as

occurring in the very distant future (i.e., rated as occurring more than one year from the present), while the other future events were distributed across the other eight temporal categories.

It is also of relevance that a greater number of the nearest future events (i.e., rated as occurring later the same day) was produced in response to self-generated cues than in response to cue-words and short verbal sentences, $\chi^2(2) = 12.32$, $p < .01$. Indeed, as shown in Figure 2.2, only in the case of future events elicited by means of self-generated cues, the percentage of the most temporally distant self-generated future events (i.e., 26.67 % of future events expected to occur more than one year from the present) was almost equivalent to the percentage of the nearest self-generated future events (i.e., 28.33 % of future events rated as occurring later the same day).

2.4.4 Thematic content

Following D'Argembeau et al. (2011), the thematic content of each event was categorised as referring to 'work' (i.e., thoughts or episodes related to school or work), 'leisure activities' (e.g., thoughts or episodes related to hobbies, parties, sports, vacation, etc.), 'relationships' (e.g., thoughts or episodes that centre on one's relationship with friends, parents, children, boyfriend/girlfriend, etc.) and 'errands' (e.g., planning to buy something, to take an appointment, etc.). Moreover, each future event was also classified according to whether it referred or not to life-scripts (the classification criteria were adapted from Berntsen and Rubin, 2004). A random selection of 25% of future events was scored by a second independent rater who was blind to the purpose of the study; there was an excellent agreement between the two raters ($k = .66$, $p = .003$).

It was observed that the content of future events varied as a function of cue type, $\chi^2(6) = 28.7$, $p < .001$. In particular, as illustrated in Table 2.4, future events denoting leisure activities and relationships were roughly equally distributed across tasks. Future events related to work were mainly produced in response to cue-words (40% of all the future events denoting work) and short verbal sentences (40% of all the

future events denoting work). In contrast, future events referring to errands were almost exclusively produced in response to self-generated cues (85 % of all the future events denoting errands).

	Self-generated cues	Cue-words	Short verbal sentences
Work (%)	15.25	31.58	32.14
Leisure activities (%)	20.34	28.07	26.78
Relationships (%)	35.59	35.09	41.07
Errands (%)	28.81	5.26	0

Table 2.4. Percentages of future events generated by participants as a function of content and cue type (self-generated cues, cue-words and short verbal sentences).

Finally, 59.26 % of all future events produced in the present study denoted established life-scripts, and were mainly concentrated in the most temporally distant future, $\chi^2(8) = 36.3$, $p < .001$ (i.e., 15.62 % were rated as occurring one year from the present and 54.69 % were rated as occurring in more than one year from the present). Nevertheless, the frequency of life-scripts did not vary as a function of the type of cue used to prompt prospection, $p = .38$.

2.5 Discussion

The present study investigated whether and to what extent future events described in response to self-generated cues differ from future events elicited by means of the more commonly used cueing techniques, namely cue-words and short verbal sentences (i.e., by experimenter-provided cues). To this aim, these two forms of future simulation were systematically compared with respect to their amount of internal and external details, phenomenal characteristics, temporal distribution, and thematic content.

As regards the quality of future representations, the results showed that, overall, future events described in response to self-generated cues contained less internal details than future events prompted by means of short verbal sentences. This difference may be accounted for by the structure imposed by the different types of cues. Short verbal sentences and self-generated cues may be considered as imposing the largest and the smallest structure to future events, respectively. Indeed, short verbal sentences provide a pre-established story structure for the unfolding event that participants have merely to enrich within their descriptions, while self-generated cues require participants to construct a completely novel future representation. Single word cues reasonably lies in the middle of this continuum as, although having been imposed by another person, they do not provide a whole scenario within which to project the event. To this respect, it is interesting to note that the number of internal details of future events elicited by means of single words ($M = 10.05$, $SE = 1.19$) is halfway between (although not statistically different from) the number of internal details of future events elicited by means of self-generated cues ($M = 8.21$, $SE = 0.56$) and the number of internal details of future events elicited by means of short verbal sentences ($M = 12.98$, $SE = 1.77$).

These findings seem therefore to support the hypothesis (Maguire & Hassabis, 2011) that prompting prospection by providing pre-arranged scenarios may decrease the cognitive load and the level of imagination required, thus facilitating the action of constructing a detailed future representation. Besides, when prospection is elicited by means of less structured cues (i.e., self-generated cues) people may favour general, semantic information, rather than specific details, as semantic information is more accessible (Maguire & Hassabis, 2011; see also D'Argembeau & Demblon, 2012, D'Argembeau & Mahy, 2012). The activation of a general knowledge structure is indeed the first step towards future thinking and provides a context within which to retrieve and reshuffle specific details (D'Argembeau & Mahy, 2012).

As far as the phenomenal characteristics are concerned, it was found that future events prompted by means of self-generated cues did not differ from future events elicited by means of experimenter-provided cues in terms of richness, accessibility, feeling of pre-experiencing and novelty. Nevertheless, the subjective rating of

personal relevance of future representations was significantly higher, as could be reasonably expected, when the events were prompted by means of self-generated cues as compared to when they were elicited by means of experimenter-provided cues; as self-generated cues had been produced by participants themselves, they were more likely to elicit future events referring to self-relevant topics (i.e., already planned personal events, personal future goals, etc.) as compared to experimenter-provided cues.

As regards the temporal distribution of future representations, it was observed that, overall, future events were most often rated as occurring in the most temporally distant future (i.e., more than one year from the present). In addition, analyses of the thematic content (D'Argembeau et al., 2011), revealed that the majority of the most temporally distant future events referred to canonical cultural life-scripts (e.g., getting married). Therefore, the present results complement earlier findings showing that the frequency of life-scripts increases with increasing temporal distance from the present (Berntsen & Jacobsen, 2008).

How to explain the high number of very distant future events and the fact that most of these concerned life-scripts? Both findings are likely due to a combined effect of, at least, two factors: The ease with which one can access general representations of his/her own future and the age of participants.

As regards the first factor, it has been recently proposed that general knowledge about one's personal future (i.e., personal semantic information and anticipated general events) is overall more accessible than specific, episodic information of similar experiences (Spzunar, 2010; D'Argembeau & Demblon, 2012). For instance, Szpunar (2010) claimed that "abstracted (semantic) representations that are relevant to a given situation should generally be more accessible than episodic representations of similar information" (Szpunar, 2010, p. 156). It is, indeed, reasonable to assume that people find it easier to access more generalized and established narratives of personal future (i.e., life-scripts) because this process bypasses the need to construct and contextualize more specific representations of the future. Furthermore, D'Argembeau and Demblon (2012) showed that prospection strongly relies on general autobiographical knowledge structures that link and organize imagined

events according to broader themes and sequences, especially for the distant future. From this perspective, life-scripts may represent one of the organisational principles that contribute to structure temporally distant prospection.

As regards the age factor, it is relevant to notice that the participants of this study were all in the second decade of their life, when the frequency of important life-script peaks (Berntsen & Rubin, 2004). Therefore, one may reasonably expect that the number of very distant events as well as the number of life-scripts decrease as people get older as a function of a shorter life expectancy and a lower amount of life-scripts to satisfy.

Furthermore, only in the case of future events generated in response to self-generated cues, the percentage of the most temporally distant future events was almost equivalent to the percentage of the nearest future events. This result may not be surprising if one assumes that one of the primary functions of future thinking is to help people plan and coordinate personal behaviour (D'Argembeau et al., 2011; Spreng & Levine, 2006). Indeed, the thematic content of the closest self-generated future events was mainly related to errands and referred to low-level details of actions (e.g., what to buy while going back home). Thus, when projecting into the future is less constrained, people may be more prone to think of future events that loom nearer to the present, as they have clearer and more activated representations of the kinds of actions and decisions they intend to make (Trope & Liberman, 1998).

Contrary to the large percentage of future events expected to occur in the very near and very distant future, a very low percentage of future events were rated as likely to occur in an intermediate temporal distance (i.e., from the next few days to the next few months). It may be that, unlike very near and very distant future events, which rely on a sort of 'pre-packaged' future representations, future events allocated in the median position of the temporal distribution may appear more obscure and uncertain, hence, less accessible and more difficult to represent.

Importantly, these results concerning the temporal distribution of future representations are at odds with previous research showing that the frequency of future events decreases with increase in temporal distance (D'Argembeau et al.,

2010; Spreng & Levine, 2006). The differences between the two patterns of results might be plausibly attributed to the different methods used to elicit prospection and/or to the number of experimental trials. Indeed, while in earlier investigations the authors collected a large number of future events for each participant (90 future events, prompted by cue-words, were collected by Spreng and Levine, 2006; between 27 and 102 daily experienced future thoughts were analysed by D'Argembeau et al., 2011), the present analysis included only three future events described in response to the first three self-generated cues produced during the Autobiographical Fluency Task and three future events produced in response to both single words and short verbal sentences. Thus, the present results are mainly based on the analyses of the most immediate and, likely, most representative future events experienced by each participant in each experimental task. Future studies should focus on ascertaining whether different temporal distribution patterns of future events may be observed as a function of the number of experimental trials taken into account.

To summarize, the findings of this study may contribute to improve our understanding of prospection in at least two ways. Firstly, they highlighted how future events elicited by means of self-generated cues differ from future events cued by means of more structured cues, i.e., short verbal sentences. Indeed, future events produced in response to self-generated cues had a less specific representational format and tended to swing between the very distant and the very near future, as compared to future events produced in response to short verbal sentences that were more specific and were mainly rated as occurring in very distant future. These results, although preliminary, suggest that the type of cue can shape the characteristics of future episodes; this information is crucial for those who wish to study the characteristics of prospection.

Secondly, the results concerning the temporal distance and the content of future events produced in response to self-generated cues provide important information on the functional relevance of prospection. Indeed, the large percentage of future events elicited by means of self-generated cues expected to occur in the very near and in the very distant future was related to errands and life-scripts, respectively. These

findings, in line with previous ecological investigations on future thinking (D'Argembeau et al., 2011; Berntsen & Jacobsen, 2008), suggest that self-generated prospection mainly reflects everyday regularities and culturally shared future expectations, potentially indicating that these are the types of future events that people foresee more often in everyday life.

Future research needs to explore in more depth the issues raised by the present findings, in order to reach a better comprehension and a more sophisticated conceptualization of human prospection.

3 Desirable and undesirable future thoughts call for different scene construction processes ²

3.1 Introduction

The two most influential theories on the cognitive underpinning of prospection (Hassabis & Maguire, 2007; Schacter & Addis, 2007) have not explicitly addressed the issue of whether different processes might be involved in the representation of different types of future scenes. More specifically, the “constructive simulation hypothesis” (Schacter & Addis, 2007) maintains that, for the purpose of engaging in mental excursion into the future, people extract and rearrange snippets from their autobiographical past. The “scene construction hypothesis” (Hassabis & Maguire, 2007) contends that past episodic memories and imagined future events are (re)constructed along analogous lines.

Neuroimaging (Addis et al., 2007; Okuda et al., 2003), behavioural (Addis, Musicaro, Pan, & Schacter, 2010; D’Argembeau & Van der Linden, 2004; Gamboz et al., 2010), and neuropsychological studies (Berryhill, Picasso, Arnold, Drowos, & Olson, 2010; de Vito et al., 2012; Klein et al., 2002) have reported marked differences or dissociations (Irish et al., 2012) between episodic memory and prospection, suggesting that future oriented mental time travel is a multifaceted phenomenon and does not rely exclusively on a particular form of memory (for a review, see Irish & Piguet, 2013).

Atance and O’Neill (2001) had the interesting intuition that people may rely on different cognitive processes when generating best-case or worst-case scenarios.

This intuition has been corroborated only partially by extant literature, which has shown that the emotional valence of future thinking may affect crucial characteristics of simulations. D’Argembeau and Van der Linden (2004) reported that

² de Vito S., Neroni M.A., Gamboz N., Della Sala S., & Brandimonte M.A. (2014). Desirable and undesirable future thoughts call for different scene construction processes. *The Quarterly Journal of Experimental Psychology*, 68(1), 75-82

representations of positive events contained more sensorial details, clearer information related to time, and were associated with a greater feeling of pre-experiencing than representations of negative events.

Valence also influenced the speed that participants took to generate future simulations, with negative future thoughts coming to mind more slowly as compared to positive thoughts (D'Argembeau & Van der Linden, 2004; Newby-Clark & Ross, 2003). Similarly, D'Argembeau, Renaud and Van der Linden (2011) observed that when participants were experiencing future simulations, positive thoughts were more frequent, more specific and were associated with a greater amount of visual images than negative thoughts.

In a diary study of involuntary and voluntary mental time travel, Berntsen and Jacobsen (2008) observed a marked prevalence of positive events compared to negative ones, in particular in the future conditions. Likewise, future events were rated significantly as more positive than past events (Newby-Clark & Ross, 2003). These positive-bias schemata contribute to guide the construction of future simulations (Taylor & Brown, 1998). Taylor and Brown (1998) suggested that uncorrected positive future scripts might be adaptive in motivating people to engage in novel situations, such as social relationships or productive jobs. Negative future thoughts may increase the chance of survival, by correcting positive illusions (see also Janoff-Bulman, 1989; Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; for a review see McGaugh, 2004; for a discussion see Berntsen & Bohn, 2010). Hence, important functional differences may underlie positive and negative future thoughts.

Given these differences in positive and negative future events, one might hypothesize that these two types of future thinking do not share the same mechanisms of scene construction.

The present study aimed at examining whether and, if so, to what extent the emotional valence associated with simulated future personal experiences influences the cognitive processes, by eliciting different types of prospection. The subjective and objective features of future mental time travel were manipulated by solely changing the instructions. This allows to assess whether it is possible to fractionate

prospection into types of prospection that may be differently constructed. In order to address this issue, healthy participants were instructed to construct two types of scenario, desirable and undesirable ones.

In line with previous evidence showing that the emotional valence of prospection affects crucial characteristics of future events (e.g. D'Argembeau & Van der Linden, 2004; Newby-Clark & Ross, 2003), it was expected that desirable future events would be more specific, more clearly represented and more accessible than undesirable future events.

Furthermore, if the optimistic bias has an adaptive function and induces people to frequently access uncorrected positive schemas (e.g., Taylor & Brown, 1998), desirable future events should be largely constructed around positive life-script. By contrast, to the extent that simulating negative future events increases the chance of survival by correcting positive illusions on the basis of the experience (e.g., McGaugh, 2004), undesirable future events should be more realistic and more grounded into previous personal past experiences.

3.2 Method

3.2.1 Participants

Thirty-five young adults (twenty-four women) entered this experiment. Participants were right-handed students recruited at Suor Orsola Benincasa University, in Naples (Italy). Their average age was 20.61 years ($SD = 4.03$). None was under psychoactive pharmacological treatment or had a history of neurological or psychiatric disorder. Participants did not receive any honorarium. Before starting the testing session, participants signed an informed consent form. The study procedures were approved by the local ethical committee and were carried out in accordance with the Declaration of Helsinki.

3.2.2 Materials and Procedure

Testing was carried out in one single session. All participants were tested individually and sat facing the same experimenter in a quiet testing environment. Participants were initially briefed that they would be required to mentally pre-experience eight autobiographical episodes occurring in the future (four desirable and four undesirable). They were also told that after each description they would complete a 7-point scale rating about some characteristics of the episode, and finally they would answer an open question concerning each event.

In the “desirable episodes” condition, participants were instructed to imagine an event that they wished to happen to them in the next few years. In the “undesirable episodes” condition, participants were required to imagine an event that they did not wish to happen to them in the next few years. Half participants performed the “desirable” task first, followed by the “undesirable” task; the other half received the opposite sequence.

For each participant, eight cue-words were randomly selected from a larger pool including twenty words taken from the Burani, Barca and Arduino (2001) Italian norms, and matched for familiarity, frequency, imageability, and concreteness. Each word was written on a card that was presented, one at a time, and remained in view for all the duration of the description (see Appendix C for the complete set of words).

Participants were encouraged to produce temporally and contextually specific events and to vividly imagine novel and plausible future episodes. Following the paradigm of D’Argembeau and Mathy (2011), they were instructed to say everything that came into their mind from the time they heard the instructions to when they successfully imagined a precise event. Participants were allowed to keep on verbally illustrating the event until they thought that nothing else could be added. There was no time limit but time of response was taken. Furthermore, the prompting procedure was maintained constant for the participants in both the experimental conditions. When participants stopped talking, the experimenter asked only once whether there was any further detail that they would have liked to add.

Simulations were digitally recorded to enable later transcriptions and subsequent scoring of the participants' responses. In the transcription phase, the time used for the initial description of /general personal knowledge (which introduced the main future episode; D'Argembeau & Mathy, 2011) was separated by the time used to describe the main episode proper.

After the transcription, a trained rater, who was blind to the hypothesis of the study, used the standardized scoring procedure developed by Levine, Svoboda, Hay, Winocur and Moscovitch (2002) to systematically parse the details generated in the past and future events. This allowed the rater first to segment the main event (i.e., the most talked about, with a brief timeframe) into details and then to distinguish between (a) internal details (i.e., information pertaining to the main event, specific to time and place) and (b) external details (general knowledge related to the event). A second rater, trained for this purpose, scored 20 random protocols. Internal details were further categorized into: (a) event (happenings, individuals present, physical/emotional actions and reactions, weather), (b) place (information about the environment where the event occurred), (c) time (date, season, month, day of the week, time of day), (d) perceptual (sensory information, body position) and (e) emotion (emotional state, thoughts). External details were categorized into: (a) external event (specific details from other incidents, from all of the above categories, external to the main event), (b) semantic (general knowledge or facts, ongoing events, extended states of being), (c) repetition (unsolicited repetition of details), and (d) other (metacognitive statements, editorializing). An example of the scoring procedure can be found in Appendix B. The inter-rater reliability (r) between the original rater and the second rater was $r = .92$, $p < .001$ for the internal details, and $r = .82$, $p < .001$ for external details.

Moreover, participants rated each event, using a 7-point scale (Szpunar & McDermott, 2008), on measures referring to the sensorial clarity index (visual details, smells, sounds, and global clarity; 1 = vague, 7 = clear), and to the clarity of the spatial temporal context index of the event (clarity of location, clarity of temporal connotation of the event; 1 = vague, 7 = clear).

Soon after the main experiment, participants met with three further questions aimed at investigating the source of their representations. Participants indicated the source of each future event by rating (a) how often they had experienced in the past a similar event (1 = never; 7 = very often), and (b) how often they had imagined in the past a similar event (1 = never, 7 = very often). Similarly, at the end of the task, they were explicitly required to specify where they thought they drew their scenario (from past autobiographical experiences or from semantic knowledge).

A rater, who was blind to the hypothesis of the study, categorized the events that contained cultural life script (i.e., marriage, having children, retirement, begin job, loose job, fall in love, own death, other's death, parent's death, partner's death, divorce, long trip, serious disease, major achievement, settle on career; Berntsen & Bohn, 2010) and those that did not contain cultural life scripts.

A subgroup of 10 participants also completed the Italian version of the State-Trait Anxiety Inventory (STAI) (Piedrabissi & Santiniello, 1989; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), which measures, on a self-reported basis, Trait Anxiety (general level of anxiety experienced by the individual) and State Anxiety (the contingent level of anxiety). Participants answered only once to the Trait Anxiety questions, and, after each episode, to the State Anxiety questions. This test was included to ensure that the State Anxiety did not affect the quality of the future episodes, and in particular that of the undesirable ones.

3.3 Statistical Analyses

Differences between desirable and undesirable future events were assessed by conducting five sets of analyses.

First, mean numbers of internal and external details produced by participants in the desirable and undesirable condition were analysed by means of a 2 (Desirable vs. Undesirable) X 2 (Internal vs. External) repeated measures analysis of variance

(ANOVA) in order to assess whether the level of specificity of the participants' descriptions was affected by the emotional valence of future events.

Second, in order to investigate to what extent the valence of future events influences their phenomenological characteristics, mean ratings on sensorial clarity and clarity of spatial temporal context provided for desirable and undesirable future events were analysed by means of independent t-tests.

Third, independent t-test were also used to compare the two ratings concerning the supposed source of the desirable and undesirable events in order to establish whether the valence of future events determines which type of information is used to mentally construct the future representations. For both the analysis concerning the phenomenological characteristics and source of future events, in order to correct for multiple comparisons, the Bonferroni adjustment was applied, $\alpha = .025$.

Fourth, the time of response, the time used for the initial description of general personal knowledge, and the time used for describing the main event in the two conditions of desirable and undesirable future thinking tasks were compared using independent t-tests. Also in this case, Bonferroni adjustment was adopted, $\alpha = .016$.

Finally, in order to ensure that the general and contingent level of anxiety did not affect the quality of the future episodes, two linear regression analyses were conducted on the scores obtained on the State Anxiety Questionnaire and on the Trait Anxiety Questionnaire.

3.4 Results

3.4.1 Amount of details

The 2 (Desirable vs. Undesirable) X 2 (Internal vs. External) repeated measures ANOVA) revealed significant main effects of future thinking condition, $F(1, 34) = 29.94$, $p < .05$, $\eta_p^2 = .15$, and details, $F(1, 34) = 35.12$, $p < .001$, $\eta_p^2 = .51$. As

shown in Table 3.1, participants generated a greater number of details during the desirable condition than in the undesirable condition, and, they reported, overall, a greater number of internal than external details ($M = 7.22$, $SD = 4.59$).

A significant interaction between future thinking task and details, $F(1, 34) = 7.31$, $p < .05$, $\eta_p^2 = .18$, indicated that fewer internal details were produced in future undesirable episodes than in future desirable events, $t(34) = -2.78$, $p < .01$, $\eta^2 = .18$ (see Figure 3.1).

	Internal Details	External Details
Desirable events	10.22 (.96)	3.45 (.39)
Undesirable events	8.05 (.79)	3.78 (.44)

Table 3.1. Mean number (and standard errors) of internal and external details produced in the future thinking task as a function of desirability (Desirable and Undesirable).

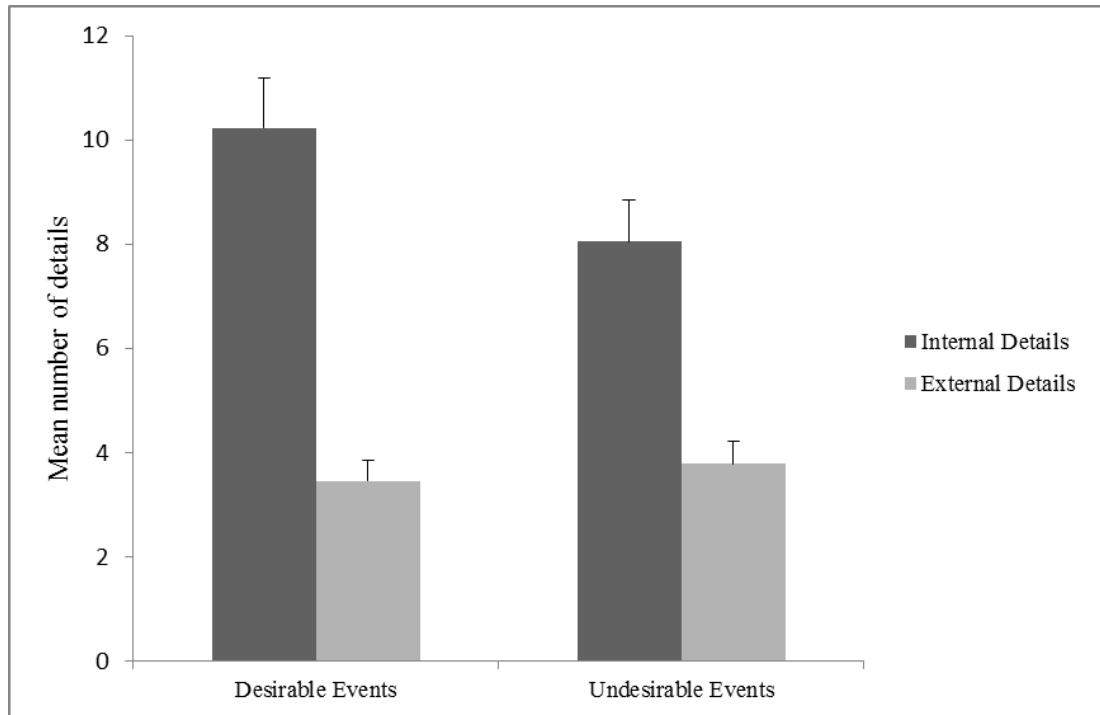


Figure 3.1. Mean number of internal and external details produced in the future thinking task as a function of desirability (Desirable and Undesirable). Error bars show standard errors of the mean.

3.4.2 Subjective rating of characteristics

With respect to the sensorial clarity of the event, desirable future episodes were considered significantly clearer than the undesirable ones, $t(34) = -2.35$, $p = .025$, $\eta^2 = .14$ (see Table 3.2), Similarly, the spatial temporal context was judged significantly clearer in desirable than in undesirable future episodes, $t(34) = -2.9$, $p < .01$, $\eta^2 = .20$ (see Table 3.2).

	Sensorial clarity Index (1 = vague; 7 = clear)				Temporal clarity Index (1 = vague; 7 = clear)	
	Visual details	Smells	Sounds	Global clarity	Clarity of location	Clarity of temporal connotation of the event
Desirable events	6.21 (.12)	3.13 (.34)	4.18 (.34)	6.18 (.24)	5.97 (.23)	4.88 (.15)
Undesirable events	5.72 (.20)	2.65 (.35)	3.96 (.35)	5.83 (.18)	5.62 (.20)	3.79 (.35)

Table 3.2. Mean ratings (and standard errors) of phenomenological characteristics of future events as a function of desirability (Desirable and Undesirable).

3.4.3 Source of the event

As shown in Table 3.4, participants referred to having imagined more often in the past a similar event in the desirable than in the undesirable condition, $t(34) = -3.78$, $p < .005$, $\eta^2 = .29$.

Furthermore, participants were not equally likely to indicate autobiographical memory as the main source of their desirable and undesirable recollections, $\chi^2(1) = 12.98$, $p < .001$. Indeed, autobiographical memory was considered the main source of 92 out of the 140 undesirable simulations (65.71%); whereas it was indicated as main source of 62 out of the 140 desirable simulations (44.28%).

Finally, participants were not equally likely to use cultural life scripts in desirable and undesirable simulations. Cultural life scripts were not contained in 100 out of the 140 undesirable simulations (71.42%) and in 77 out of the 140 desirable simulations (55%); this difference is significant, $\chi^2(1) = 7.73$, $p < .01$ (see Table 3.4).

	Autobiographical experiences (%)	Semantic knowledge (%)	Life-scripts (%)
Desirable events	65.71	34.28	45
Undesirable events	44.28	55.71	28.57

Table 3.4. Percentages of future events rated as referring to autobiographical experiences, semantic knowledge and life-scripts as a function of desirability (Desirable and Undesirable).

3.4.4 Time of response

The results showed that participants used overall the same amount of time to describe the event in desirable ($M_{\text{sec}} = 51.99$, $SD = 20.9$) and in undesirable conditions ($M_{\text{sec}} = 51.91$, $SD = 20.28$). However, undesirable future episodes required more time for their initial general description ($M_{\text{sec}} = 15.20$, $SD = 13.71$), if compared to desirable events ($M_{\text{sec}} = 10.14$, $SD = 10.95$), $t(34) = 2.77$, $p = .01$, $\eta^2 = .18$.

	Time of response	Initial description (general knowledge)	Description of the main event
Desirable events	9 (1.4)	10.14 (1.7)	51.99 (3.9)
Undesirable events	10.8 (1.9)	15.20 (1.2)	51.91 (4.1)

Table 3.5. Mean response times in Msec (and standard errors) as a function of desirability (Desirable and Undesirable).

3.4.5 Anxiety Inventory

A linear regression showed that the global scores obtained on the STAI explained part of the variability of the number of internal details, $r^2 = .22$, $F(1, 19) = 3.57$,

$p = .05$. This was true solely with respect to the trait anxiety scores, $\beta = .65$, $t(19) = 2.67$, $p < .05$, $\eta^2 = .20$.

	Trait Anxiety	State Anxiety
Desirable events	44.6 (1.87)	36.67 (2.55)
Undesirable events	44.6 (1.87)	38.45 (4.19)

Table 3.6. Mean ratings (and standard errors) of the scores obtained on the Trait Anxiety and State Anxiety Questionnaire (STAI) as a function of desirability (Desirable and Undesirable).

3.5 Discussion

The implicit assumption on the cognitive underpinning of prospection is that all future thoughts share the same underlying cognitive processes (Hassabis & Maguire, 2007; Schacter & Addis, 2007). This might have led authors to overlook the possibility that different forms of future simulations call for a variety of memory and visual imagery processing.

The purpose of this study was to investigate whether or not future thoughts are differently constructed depending on their emotional valence. Striking differences were observed on almost all the measures considered. A significantly greater percentage of desirable events than undesirable events contained life scripts. Berntsen and Bohn (2010) stated that life scripts are likely to influence the search descriptions that people follow when instructed to generate past and future scenarios. They observed that most of the “important” past and future events referred to events that are part of cultural life scripts (see also Berntsen & Rubin, 2004). The results of the present study allow to refine this concept, by showing that desirable events activate life script to a greater extent than undesirable events.

It was also observed that both desirable and undesirable future episodes required an initial general description. From this perspective, the present results replicated previous findings, by showing that activating a general knowledge structure is the

first step to prospection and provides a context within which to retrieve and reshuffle specific details. Crucially, the results of this study also showed that general knowledge description lasted significantly longer during undesirable than during desirable episodes. Therefore, as Newby-Clark and Ross (2003) posited, people appear to take longer to generate future negative than positive episodes. These results are consistent with the fact that a life script, which is “a culturally shared part of our semantic knowledge” (Berntsen & Bohn, 2010, p. 267), may greatly help to structure individual self-narratives. Thus, future episodes that contain life scripts should generally be more accessible than episodes not revolving around a life script (Szpunar, 2010). Life scripts facilitate mental time travel (Berntsen & Bohn, 2010), even if at the end of the process the quality of the content (e.g., contextual details) of the two types of episodes (with or without life script) may be very similar (Klein, 2013).

Taylor and Brown (1988) suggested that the easier access to positive future thoughts might enable people to construct richer representations. Accordingly, the results of the present study showed that desirable events generated a greater amount of internal details. This finding could hardly be accounted for by the fact that thinking of undesirable events increased the level of contingent anxiety. In fact, an overall increment of internal details generated by participants with higher anxiety scores was observed, regardless of the experimental condition. Desirable events were considered more vivid than undesirable and were framed within a better defined spatial temporal context (see also D'Argembeau & Van der Linden, 2004). This may be due to the fact that undesirable episodes are less often imagined than desirable events—that is, they are more novel, as participants in the present study acknowledged. People are more prone to imagine positive events (Berntsen & Jacobsen, 2008) and to focus on optimistic scenarios (Newby-Clark, Ross, Buehler, Koehler, & Griffin, 2000). The act of imagining future events (positive or negative) makes them seem more plausible and more likely to occur (Sherman, Cialdini, Schwartzman, & Reynolds, 1985; Szpunar & Schacter, 2013). Thus, people may be less willing to think of undesirable, unpleasant future scenarios and engage more often with thoughts of desirable future events. People tend to enrich in details the conceptual, general knowledge about their personal future each time they think of it. Szpunar and

Schacter (2013) observed that, despite the fact the participants were explicitly instructed to avoid adding new details across repeated simulations, the number of details of the scenarios always increased when they were re-simulated. This may be the reason why desirable episodes, which are more often thought about, are richer in details and more vivid than undesirable ones.

Finally, the results of the present study revealed that participants were more likely to indicate autobiographical memories as the source of their undesirable events, whereas they equally related the simulations of desirable events to autobiographical events and semantic knowledge. Furthermore, participants stated that they had imagined more often desirable than undesirable episodes. It is of course difficult to draw inferences about the nature of a memory experience based on the analysis of verbally produced content, which is not inherently episodic or semantic memory based. However, the frequency with which one thinks of certain episodes may contribute to “semanticize” them. As the stories that are told and retold over the years may become anecdotal to some extent, also the scenarios that are imagined and re-imagined may be perceived as less personal and more prototypical.

It is noteworthy to notice that changing the emotional valence of a future thought may affect the outcome that participants provide and the individual perception of a future thought, with desirable thoughts being perceived as more vivid and anecdotal. Tolstòj (2003, p. 21) must have experienced the same perception, when at the incipit of *Anna Karenina* wrote: “Happy families are all alike; every unhappy family is unhappy in its own way”.

Second Part

Prospection in ageing and amnesia: a critical appraisal

While there is now substantial evidence that episodic memory plays a key role in the elaboration of future scenarios, some recent studies suggest that other representational structures, such as semantic memory and conceptual knowledge, are also involved in this process (e.g., Klein, 2013). An important source of support for this hypothesis comes from neuropsychological research revealing that amnesic patients may be able to construct future simulations based on well-established scripts in semantic memory or more generalized memory for routine events, which do not place demands on episodic memory (Cooper et al., 2011; Maguire, Vargha-Khadem, & Hassabis, 2010).

Nevertheless, in some occasions, access to this semantic store may be not sufficient for detailed and specific representations to be shaped (Race et al., 2013). For instance, Race and colleagues (2013) observed that although amnesic patients with medial temporal lobes lesions were able to list general issues relevant to the future, when probed to elaborate on these issues, the patients produced impoverished descriptions compared to those of controls. Along similar lines, Kwan, Craver, Green, Myerson and Rosenbaum (2012) documented preserved future-oriented decision making in K.C., a patient with dense autobiographical amnesia resulting from a head injury, despite his inability to construct specific future scenarios in which he could use future rewards (see also Kwan et al., 2013).

Together these findings seem to suggest that, at least on some instances, the temporal and the constructive processes underlying prospection are dissociable (Kwan et al., 2012). Support for this hypothesis has been provided by a few studies revealing that some patients suffer from a deficit in scene construction that may be, in many ways, independent of the ability to simulate future prospects (Kwan et al., 2013). For instance, Hassabis, Kumaran, Vann, and Maguire (2007) showed that patients with episodic amnesia had deficits in imagining spatially coherent events involving

commonplace scenes that were not temporally organized (i.e., imagine a day on a tropical beach). Similarly, Rosenbaum, Gilboa, Levine, Winocur, and Moscovitch (2009) reported that patient K.C. failed to construct semantic narratives of fairy tales and bible stories that were impersonal and not necessarily temporally dated.

In light of these observations, a recent branch of research has been specifically addressing the contribution of scene and narrative construction processes to prospection by implementing description tasks requiring participants to simply describe present scenes (Gaesser et al., 2011; Zeman et al., 2013). A small number of recent studies adopting such a task revealed impoverished descriptions of the future and the present in the context of amnesia (Zeman et al., 2013, but see also Race, Keane & Verfaellie, 2011, 2013) and in healthy elderly people (Gaesser et al., 2011).

With the aim of shedding additional light on the potential mechanisms underlying the mental construction of imagined future events, the Second Part of this dissertation discusses a set of studies aimed at investigating whether a common underlying memory-related factor, the capacity to construct a rich narrative, may influence descriptions of imagined, future and present scenes alike.

In the study reported in Chapter 4, younger and older adults were involved in either an imagination/prospection task or in a pictures description task, to explore in more details (i) the effect of age on the performance in these tasks and (ii) the associations between descriptions of the present and of the future in healthy participants of varying ages.

In Chapter 5 the same tasks were adopted to assess scene and narrative construction abilities in a group of amnesic patients, hence presenting medically-documented long-term memory (LTM) deficits. It was hypothesized that, if prospection depends on narrative construction mediated by LTM-related processes, patients should demonstrate parallel impairments across all three tasks.

4 Age-related differences in scene construction and scene description

4.1 Experiment 1

4.1.1 Introduction

As discussed in the Introduction, converging evidence from cognitive psychology, neuropsychology, and neuroimaging studies shows that episodic memory plays a role in the construction of imaginary future events (e.g., Schacter et al., 2008; Suddendorf & Corballis, 2007). Most notably, studies of various neurological and psychopathological populations documented parallel reductions in the episodic specificity of past and future events in patients with Alzheimer's disease (Addis et al., 2009b), mild cognitive impairment (Gamboz et al., 2010b), amnesic syndrome (Andelman et al., 2010; Hassabis et al., 2007; Klein et al., 2002; Race et al., 2011; Tulving, 1985), depression (Williams et al., 1996), schizophrenia (D'Argembeau et al., 2008), autism (Lind and Bowler, 2010), and post-traumatic stress disorder (Brown et al., 2011).

A similar link between past and future thinking has been reported in healthy older adults (e.g., Addis et al., 2008). In particular, research on cognitive aging suggests that older adults' difficulty in imagining novel and future events is strongly influenced by their reduced access to past episodic memories (e.g., Rendell, Bailey, Henry, Phillips, Gaskin, & Kliegel, 2012).

However, it has been recently proposed that recollection difficulties alone cannot explain the age-related decline in prospection. Imagining a novel event depends, in part, on retrieving relevant information from episodic memories of similar experiences, but it also requires the actual construction of mental representations (i.e., event construction, Romero & Moscovitch, 2012). In keeping with this hypothesis, Addis, Musicaro, Pan and Schacter (2010) showed that ageing affects

mental simulation even under conditions that preclude recasting of remembered events as imagined events. In this study, participants were first provided with a set of autobiographical memories and, then, were asked to imagine novel events containing a combination of specific details extracted from these memories. Under these conditions, older adults continued to produce less detailed descriptions compared to their younger counterparts. This observation led the authors to propose that age-related problems in recombining event details may contribute to age-related difficulties in imagination and future thinking (Addis et al., 2010).

However, to date, “the processes that govern event construction are still poorly understood” (Romero & Moscovitch, 2012, p. 271).

The present experiment investigated age-related changes in scene construction adopting the procedure originally devised by Hassabis, Kumaran, Vann, and Maguire (2007). Young and older participants were instructed to mentally construct three types of scenarios: simple a-temporal scenarios (e.g., “Imagine you are in a fitting room in a shop”), complex a-temporal scenarios (taken from Hassabis et al., 2007, e.g., “Imagine you are lying on the white sandy beach of a tropical bay”), and future scenarios (taken from Hassabis et al., 2007, e.g., “Imagine a possible future meeting with a friend”).

All three types of scenarios require rich visualization and construction of scenes involving commonplace settings of self-referent events (Rendell et al., 2012). The simple and complex a-temporal scenarios were similar in that they both relied predominantly on scene construction (Hassabis & Maguire, 2007) without demands to mentally time travel (Rendell et al., 2012). However, one difference between them is that the simple a-temporal scenarios involved constrained settings, therefore reducing the amount of details that could be imagined during the description. In contrast, the future scenarios explicitly required participants to think about a time in the future (e.g., a possible event over the following weekend), thus stipulating the additional criteria of a subjective sense of self in time (autonoetic consciousness, Tulving, 1985). This distinction was highlighted by Hassabis, Kumaran, and Maguire (2007) who maintained that imagining fictitious scenarios does not necessarily imply the construction of mental representations which are temporal in nature.

It was predicted that age-related difficulties in scene construction might be modulated by the complexity of the scene to be imagined. More precisely, a more conspicuous age-effect should be observed on the complex a-temporal scenarios descriptions compared to the simple a-temporal scenarios performance, due to a higher cognitive load needed to shape a greater amount of descriptive details in an organized whole.

In addition, in line with Rendell et al. (2012), age-related reduction in autonoetic consciousness would result in a disproportionate age-related impairment when participants were required to imagine novel yet plausible future events.

4.1.2 Method

4.1.2.1 Participants

Thirty participants were recruited for the study: fifteen young adults (18 to 35 years old) and fifteen older adults (over 66 years). The performance of three outlier (+ 2 SD from the mean of their correspondent age-group) participants (one young adult and one older adults participant) was not considered in the analysis. The final sample consisted therefore of twenty-eight participants.

All of the older adults were recruited from the volunteer panel of the Psychology Department of the University of Edinburgh and received a small honorarium for their participation. All young adults were undergraduate students receiving course credits in return for their participation. Young and older adults did not differ in years of education or verbal intelligence as estimated by their performance on the National Adult Reading Test (NART; Nelson, 1982).

	Young adults (n=14)	Older adults (n=14)
Number of women	9	10
	Mean (SD)	Mean (SD)
Age (in years)	22.64 (2.98)	70 (4.22)
Education (in years)	20.71 (1.74)	19.5 (2.17)
NART- Full scale IQ	124.36 (1.5)	125.78 (1.19)

Note. NART = National Adult Reading Test which provides estimate of verbal IQ.

Table 4.1. Demographic Characteristics of Participants.

4.1.2.2 Materials and Procedure

The effects of age and scenario complexity on imagination and prospection abilities were assessed by using an adapted version of Hassabis et al.'s (2007) procedure. Participants were invited to summon up and describe imagined scenes on the basis of a brief cue read out to them by the experimenter e.g., 'Imagine you are lying on a white sandy beach in a beautiful tropical bay' (Hassabis et al.'s, 2007). Participants were asked to imagine the scene as vividly as they could and to describe it in as much detail as possible. They were asked not to describe specific memories from the past but to create new possible scenarios. A printed text card was placed on the desk in front of them summarizing the main feature of the scenario, to act as a reminder if needed.

The materials consisted of nine scenarios: three scenarios involving everyday settings -complex a-temporal scenarios (a beach, a museum and a market, taken from Hassabis et al., 2007), three scenarios involving very simple and constrained settings –simple a-temporal scenarios (a lift, a fitting room and a cubicle in a call centre) and three scenarios requiring 'episodic future thinking' –future scenarios (a possible Christmas event, a possible event in the next weekend, a possible future meeting with a friend, taken from Hassabis et al., 2007) (see Appendix D).

The order of conditions (simple a-temporal scenarios vs. complex a-temporal scenarios vs. future scenarios) was completely counterbalanced across participants. Within each condition, participants received the three scenarios' descriptions, one by one, in a random order.

It was ensured that participants maintained the goal of the task throughout. The participants' descriptions were recorded and later transcribed. In order to align the present experiment more closely with the majority of the previous studies investigating age-related differences in imagination and future thinking (e.g. Addis et al., 2008; Addis et al., 2010; Gaesser et al., 2011), the analysis were only based on the scores for the first three minutes of description, for each picture.

The participants' descriptions were scored according to the criteria of Hassabis et al. (2007). A point was given for each element that depicted either Spatial Reference (SR), Entities Present (EP), Sensory Descriptions (SD), or Thought/Emotion/Action (TEA). Specifically, the spatial reference category encompassed statements regarding the relative position of entities within the environment, directions relative to the participant's vantage point, or explicit measurements (e.g., "behind the bar" or "to my left I can see" or "the ceiling is about 40 ft high"). The entities present category was a simple count of how many distinct entities (e.g., objects, people, animals) were mentioned (e.g., "I can see some birds"). The sensory descriptions category consisted of any statements describing (in any modality) properties of an entity (e.g., "the chair I'm sitting on is made of wood") as well as general weather and atmosphere descriptions (e.g., "it is very hot" or "the room is very smoky"). Finally, the thought/emotion/action category covered any introspective thoughts or emotional feelings (e.g., "I have a sense of being alone") as well as the thoughts, intentions, and actions of other entities in the scene (e.g., "he seems to be in a hurry" or "the barman is pouring a pint"). Repetitions and irrelevant utterances were not included in the score. An example of the scoring procedure can be found in Appendix E.

For each participant a mean element score was computed for each scenario type (complex a-temporal scenarios, simple a-temporal scenarios, future scenarios) by averaging the total number of elements described across each scenario.

In their original study Hassabis et al. (2007) computed a composite score, the ‘experiential index’. This score measures the overall richness of the imagined experience, and is obtained by calculating and combining four subcomponent measures: content analysis by experimenter, self-ratings of presence and salience, self-ratings of spatial coherence, and independent rating of quality. In order to derive this score, Hassabis et al. (2007) asked all participants to rate their descriptions subjectively after completion of their last scene description. This however imposes a memory load since participants have to remember their earlier descriptions following a (filled) delay. In order to minimize such memory load and to obtain an experiential index for a specific scene, an extra imagination trial was included at the end of experiment. More precisely, participants were asked to summon up and describe a pub scene (Hassabis et al., 2007) according to the instructions provided in the previous trials. Immediately after completing their description of the imagined pub scene, participants were asked to provide self-ratings of (i) presence and salience, and of (ii) spatial coherence for this scene. This ‘pub scene’ description was subsequently scored by using Hassabis et al.’s (2007) ‘experiential index’.

4.1.2.3 Subjective measure of visual imagery abilities

Following the additional imagination task (pub scenario), the Test of Visual Imagery Control (TVIC, Gordon, 1949; Richardson, 1969) and the Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973) were administered to assess participants’ subjective appraisal of their imagery abilities. The TVIC assesses the ability to form and modify a visual image, using 10 questions scored on a 5-point rating scale, yielding a maximum score of 50. The VVIQ contains 16 items rating the vividness of evoked visual imageries each scored on a 5-point scale, yielding a maximum score of 80.

The study was approved by the local Ethics Committee, and informed consent was obtained from each participant according to the Declaration of Helsinki.

4.1.3 Statistical Analyses

Two mixed factors analyses of variance (ANOVAs) were conducted to assess the effects of age and scenario complexity on participants' capability to describe imagined scenes.

First, a 2 (Scenario: complex a-temporal scenarios, simple a-temporal scenarios) X 2 (Age: young adults, older adults) ANOVA was conducted in order to assess the effects of age and scenario type on participants' descriptions.

Secondly, a 2 (Scenario: complex a-temporal scenarios, future scenarios) X 2 (Age: young adults, older adults) ANOVA was conducted in order to separate the contribution of prospection abilities and related cognitive functions in constructing mental scenarios. The alpha level was set to 0.05 for all the mixed factors ANOVAs.

Furthermore, independent t-tests comparisons were used to compare the young and older adults' performance on the number of irrelevant utterances and repetitions, on the experimental index and on the measures of visual imagery.

4.1.4 Results

4.1.4.1 Details reported

The results of the first 2 (Scenario: complex a-temporal scenarios, simple a-temporal scenarios) X 2 (Age: young adults, older adults) ANOVA revealed neither a significant main effect of Scenario, $F(1, 26) = 2.95$, $p = .098$, $\eta_p^2 = .10$, nor a significant main effect of Age, $F(1, 26) = 1.29$, $p = .27$, $\eta_p^2 = .05$, nor a significant Scenario X Age interaction $F(1, 26) = .24$, $p = .63$, $\eta_p^2 = .009$.

Nevertheless, as shown in Figure 4.1, the additional 2 (Scenario: complex a-temporal scenarios, future scenarios) X 2 (Age: young adults, older adults) ANOVA showed a significant main effect of Scenario, $F(1, 26) = 27.68$, $p < .001$, $\eta_p^2 = .52$, indicating

that the complex a-temporal scenarios were overall described in more details than the future scenarios (see Table 4.1), and a significant main effect of Age, $F(1, 26) = 5.58$, $p < .05$, $\eta_p^2 = .18$, revealing that younger adults produced overall more detailed descriptions compared to older adults (see Table 4.1). No significant Scenario X Age interaction was observed, $F(1, 26) = .87$, $p = .36$, $\eta_p^2 = .03$.

	Simple a-temporal scenarios	Complex a-temporal scenarios	Future scenarios
Young adults	18.36 (4.41)	22.15 (1.71)	16.96 (2.91)
Older adults	15.47 (2.12)	17.43 (1.5)	10.01 (1.18)

Table 4.1. Mean numbers (and standard errors) of elements reported in describing imagined scenes as a function of age.

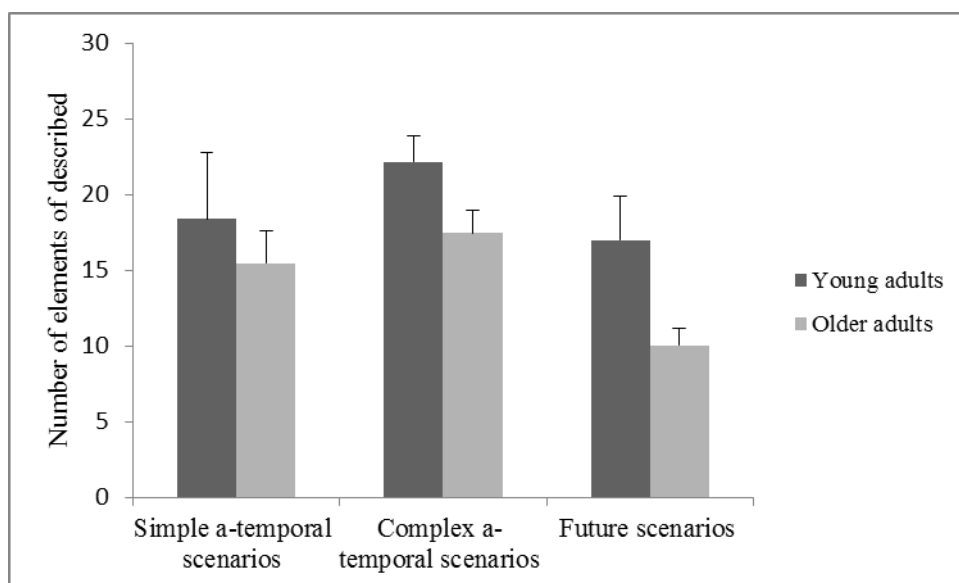


Figure 4.1. Mean number of elements produced in describing imagined scenes as a function of age.

4.1.4.2 Irrelevant utterances and repetitions

As shown in Table 4.2, the occurrence of irrelevant utterances and repetitions increased with augmenting age when participants were invited to describe the simple a-temporal scenarios, $t(26) = -3.01$, $p < .01$, $\eta^2 = .35$, the complex a-temporal scenarios, $t(26) = -3$, $p < .01$, $\eta^2 = .35$, and the future scenarios, $t(26) = -3.99$, $p < .001$, $\eta^2 = .61$.

	Simple a-temporal scenarios	Complex a-temporal scenarios	Future scenarios
Young adults	1.28 (.28)	1.42 (.41)	2 (.53)
Older adults	3.44 (.66)	4.12 (.80)	5.63 (.74)

Table 4.2. Mean numbers (and standard errors) of irrelevant utterances and repetitions produced in describing imagined scenes as a function of age.

4.1.4.3 The experiential index

The results concerning the overall experimental index conducted on the extra pub scene revealed a marginally significant effect of Age, $t(26) = 2.81$, $p = .05$, $\eta^2 = .31$, indicating a tendency for young adults to report a higher experimental index score compared to older adults (see Table 4.3).

	Content	Sense of presence	Perceived salience	Spatial coherence	Quality rater	Experimental Index
Young adults	14.5 (1)	3.78 (.26)	3.93 (.24)	4.07 (.45)	5.5 (.37)	31.79 (1.58)
Older adults	10.43 (1.79)	3.64 (.32)	3.71 (.24)	4 (.61)	3.93 (.51)	25.71 (2.59)

Table 4.3. Mean scores (and standard errors) on the different subcomponents of the experimental index (Hassabis et al., 2007), as a function of age.

Additional analysis showed a marginally significant age-related difference with regards to the mean number of elements reported in the pub scene, $t(26) = 1.98$, $p = .58$, $\eta^2 = .15$, but no reliable differences were observed concerning specifically the sense of presence, $t(26) = .34$, $p = .73$, $\eta^2 = .004$, the perceived salience, $t(26) = .62$, $p = .54$, $\eta_p^2 = .015$, or the spatial coherence, $t(26) = .09$, $p = .93$, $\eta^2 = .03$. However, young and older adults significantly differed with regards to the quality judgement index, $t(26) = 1.49$, $p < .05$, $\eta^2 = .26$ (see Table 4.3).

4.1.4.4 Subjective measures of visual imagery abilities

The mean scores in the TVIC and in the VVIQ are presented in Table 4.4. Results revealed that younger and older adults did not significantly differ in the TVIC, $t(26) = .49$, $p = .62$, $\eta^2 = .009$, or the VVIQ, $t(26) = 1.95$, $p = .06$, $\eta^2 = .15$.

	VVIQ	TVIC
Young adults	34.28 (1.88)	24.28 (1.83)
Older adults	28.71 (2.15)	22.86 (2.23)

Table 4.4. Mean scores (and standard deviations) in the subjective measures of visual imagery abilities as function of age.

4.1.5 Discussion

The purpose of the present Experiment was to investigate whether age-related difficulties in scene construction processes may be modulated by the type of scenario to be imagined, that is, complexity of scenarios (simple versus complex) and temporal aspects of scenarios (a-temporal versus. future). These scenario types will be discussed in turn.

4.1.5.1 Simple vs. complex scenarios

As stated in the Introduction, it was assumed that one difference between the simple a-temporal and complex a-temporal scenarios is that the simple a-temporal scenarios involved uncrowded and constrained settings, compared to the complex ones, so reducing the amount of details that could be added during the description. This hypothesis was not supported by the findings of the present Experiment. Indeed, participants reported, overall, an equal number of elements when describing the simple a-temporal scenarios and the complex a-temporal scenarios. In addition, and importantly, this effect was not modulated significantly by age. In fact, even though the number of descriptions overall was numerically lower in the older participants

than in the younger participants, the analysis of simple and complex scenarios revealed no significant age-related difficulty in scene construction.

One possibility, which may account for this result, is that the adoption of full-sentence descriptors in the present experiment may overall facilitate the task of constructing a scenario (see also the results of the study described in Chapter 2). Specifically, at odds with what Hassabis and Maguire (2007) maintained, it may be possible that the use of full-sentence descriptions may provide older participants with “a story structure for the unfolding events”, thus reducing cognitive load and level of imagination required and limiting the chances to detect an age-related difference on our complexity task. Nevertheless, a significant effect of age was revealed in the analysis of complex a-temporal and future scenarios, thus raising the possibility that age affects overall description capacity, as shown in previous research (e.g., Gaesser et al., 2011), but that the complexity analysis was simply underpowered.

4.1.5.2 A-temporal vs. Future scenarios

The emergence of a significant age effect in the a-temporal complex vs. *future thinking* comparison hints a disproportionate age-related difficulty in future scenarios performance, although this was not backed up statistically. Describing future scenarios necessitates, in addition to constructing a novel scene, a capacity for autonoetic consciousness and mental time travel (Rendell et al., 2012). The present finding is in line with Rendell et al.’s findings (2012) and, thus, supports their interpretation that older adults’ difficulty in mentally constructing novel scenarios may be exacerbated when there is an additional requirement of a subjective sense of self in time (autonoetic consciousness, Tulving, 1985).

4.1.5.3 Irrelevant utterances and repetitions

Finally, the results of the present experiment replicated previous findings revealing that ageing affects the amount of irrelevant utterances and repetitions produced during the description of imaginary future events (e.g., Addis et al., 2008). Indeed, older adults produced more irrelevant utterances and repetitions than young adults, when describing both a-temporal and future scenarios. This pattern of results is in line with research on narrative focus, documenting that older adults tend to focus more on communication, rather than accurate description of the story (Harwood, Giles, & Ryan, 1995), and are more prone to producing off-topic speech due to age-related decline in inhibiting irrelevant information (Hasher, Zacks & May, 1999).

In conclusion, the results of the present experiment provide support for the hypotheses that age-related decline in scene construction processes may underlie prospection difficulties typically observed in older adults (e.g., Romero & Moscovitch, 2012). However, they did not support the hypothesis that differences in task demands may be relevant in modulating the performance on scene construction tasks, as a function of age.

4.2 Experiment 2

4.2.1 Introduction

An emerging body of evidence suggests that one function of long-term memory, mediated by the hippocampus and related structures, is to supply elements from past memories that are needed for scene construction (Buckner & Carroll, 2007; Hassabis & Maguire, 2007, 2009; Schacter & Addis, 2007). In line with this hypothesis, it has been proposed that age-related differences in processes implicated in long-term

memory may be one source for the older adults' deficit in tasks requiring the construction of imagined events (Romero & Moscovitch, 2012).

To date, most prospection studies have used an open-ended cueing paradigm, emphasizing the creation of detailed imagined scenes. Such a task requires the retrieval of episodic and semantic elements from long-term memory in response to a general cue (e.g. imagine a beach scene), followed by the construction of the imagined event from those elements (Romero & Moscovitch, 2012). This procedure leaves open the possibility that variations across age in task performance may be due to differences between age groups in (i) the ability to retrieve the requisite elements from long-term memory, (ii) the availability of temporary storage of scene information, and/or (ii) the capacity to bind the retrieved elements into a coherent representation (Romero & Moscovitch, 2012).

Consequently, it has been recently proposed that the observed deficits and individual differences in such an imagination task may not be due solely to deficits in recollection and imagination, but extend to tasks requiring the simple description of scenes (e.g., Schacter, Gaesser, & Addis, 2012; Zeman et al., 2013).

Recent evidence supporting this hypothesis comes from research in healthy elderly people who present reduced long-term memory functions (Gaesser et al., 2011; Madore, Gaesser, & Schacter, 2013) and from patients with amnesia (Zeman et al., 2013). Gaesser et al. (2011) and Madore et al. (2013) documented a parallel age-related decline in reporting details during tasks requiring the description of one's own past, imagined future scenarios and pictures currently in view. These results raise the possibility that a common underlying memory-related factor, the capacity to construct a rich narrative, influences the descriptions of past, imagined future and current experience similarly (Zeman et al., 2013).

However, Race, Keane, and Verfaellie (2011, 2013) challenged this hypothesis of a general description deficit associated with impairment of long-term memory. They reported intact picture description in patients with medial temporal lobe amnesia whose reports of past events and descriptions of imagined future events were impaired. Zeman et al. (2013) argued that "important differences in task demands

might hamper direct comparison of the results across these studies” (p.7). Indeed, while Race et al. (2011, 2013) asked their amnesic participants to describe very simple drawings, Gaesser et al. (2011) used more complex illustrations. This methodological variability raises the possibility that differences in task demands might, at least partly, modulate age-related differences in scene description abilities.

To address this issue, the present Experiment compared picture description performance of young and older adults on two sets of two pictures which have been used recently in related work (leading to opposite results and not empirically manipulated) and that were judged, on the basis of results from previous studies, to differ in complexity (see Zeman et al., 2013). Two pictures were selected randomly from the study by Gaesser et al. (2011) (highly complex) and two pictures were selected randomly from the study by Race et al. (2011) (not very complex).

It was expected that ageing would selectively affect the capacity to describe the highly complex Gaesser-pictures, leaving relatively intact the ability to describe the not very complex Race-pictures.

4.2.2 Method

4.2.2.1 Participants

The same twenty-eight participants who entered Experiment 4.1 participated in the study: Fourteen young adults (18 to 35 years old) and fourteen older adults (over 66 years). For the details about participants see Experiment 4.1 and Table 4.1.

4.2.2.2 Materials and Procedure

The effects of age and picture complexity on the capacity to describe visually presented pictures were assessed by asking participants to describe two sets of two pictures which have been used recently in related work and that that were judged, on the basis of the results found in previous studies, to differ in complexity (see Zeman et al., 2013): Two pictures selected randomly from the study by Gaesser et al. (2011) (highly complex) and two pictures selected randomly from the study by Race et al. (2011) (not very complex). The order of conditions was completely counterbalanced across participants. Participants were shown the four pictures one by one, in a random order, and asked to describe them while inspecting each picture.

The pictures are shown in Appendix D. Participants were instructed to report only what was depicted in the picture without adding any other elements. The participants' descriptions were recorded and later transcribed. In order to align the present study more closely with Gaesser et al.'s (2011) and Race et al.'s (2011) studies, only the scores for the first three minutes of description, for each picture, were considered and scored.

As in the Experiment 4.1, participants' descriptions were scored according to the criteria of Hassabis et al. (2007). A point was given for each element that depicted either Spatial Reference (SR), Entities Present (EP), Sensory Descriptions (SD), or Thought/Emotion/Action (TEA), not including repetitions and irrelevant utterances. These scores were added together to compute an element score for each of the four picture descriptions per participant. An example of the scoring procedure can be found in Appendix E. In the analyses, average element scores were used for Race et al.'s pictures and Gaesser et al.'s pictures, respectively.

Finally, in order to verify whether the presumed different complexity of the two sets of pictures was supported by the participants' subjective ratings, participants were also asked to rate, on a 5-point scale, the perceived difficulty of the two sets of

pictures previously described. This was done by showing the participants all four pictures again, one by one, after the main task (see Appendix G).

The study was approved by the local Ethics Committee and informed consent was obtained from each participant according to the Declaration of Helsinki.

4.2.3 Statistical Analyses

A 2 (Picture type: Race-pictures, Gaesser-pictures) X 2 (Age: young adults, older adults) mixed factors analysis of variance (ANOVA) was conducted in order to assess the effects of age and picture types on pictures' descriptions. When necessary, post-hoc comparisons contrasted the relevant experimental conditions. In order to correct for multiple comparisons, significance was set at $\alpha = .025$.

4.2.4 Results

A significant main effect of Picture type, $F(1, 26) = 15.95$, $p < .001$, $\eta_p^2 = .38$, showed that participants, overall, described in more detail the Race-pictures than the Gaesser-pictures (see Figure 4.2). No significant main effect of Age was observed, $F(1, 26) = 3.18$, $p = .09$, $\eta_p^2 = .11$. It was also observed a significant Picture type by Age interaction, $F(1, 26) = 12.98$, $p = .001$, $\eta_p^2 = .33$.

Post-hoc comparisons showed that young and older adults did not significantly differ in their capacity to describe the Race-pictures, $t(26) = .49$, $p = .63$ (see Table 4.5). In contrast, when describing the Gaesser-pictures, young adults reported more elements than did older adults, $t(26) = 2.77$, $p = .01$, $\eta^2 = .23$ (see Table 4.5), so replicating Gaesser et al.'s (2011) findings.

	Race-pictures	Gaesser-pictures
Young adults	54.82 (5.82)	53.64 (7.86)
Older adults	50.68 (6.21)	27.82 (4.99)

Table 4.5. Mean numbers (and standard errors) of elements described in the Race-pictures and in the Gaesser-pictures as a function of age.

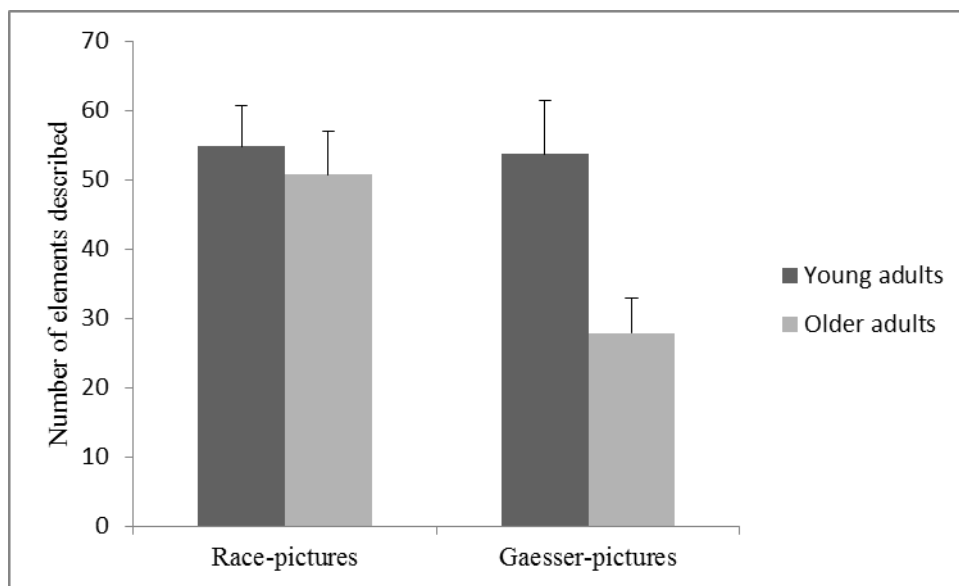


Figure 4.2. Mean number of elements described in the Race-pictures and in the Gaesser-pictures as function of age.

4.2.5 Discussion

The present experiment assessed whether the contrasting results found in Race et al.'s (2011, 2013) studies and in Gaesser et al.'s (2011) studies could be accounted for by differences in task demand.

The results revealed that ageing did not affect the capacity to describe the Race-pictures, but it affected the performance for the Gaesser-pictures. A possible explanation for these results is that the higher visual complexity of the Gaesser-pictures hampered older adults' capacity to select the most appropriately nested narrative to supply rich descriptive details, ultimately leading to impoverished descriptions.

In particular, it was observed that, when describing the Gaesser-pictures, older adults' were more prone, compared to young adults, to lump together similar items in superordinate categories, ignoring minutiae (e.g., young adults: "there is a man sitting at the table on his own, he has got a drink it could be coca cola and some dishes... He has got bowls and trays and there is a red kind of tray area as well...There is a tray here but there is no-one sitting at this table...This other man is sitting and eating, he has got a kind of spoon and it could be a fork...there could be some chips on his plate....he is just about to pick them ...there is a bottle of water or whatever..."; older adults: "It is a very crowded canteen with a lot of people eating....There are a lot of trays and dishes...Some people are eating, some people are chatting..."). This was not the case for the Race-pictures (e.g., young adults: "the mother is sitting and reading on a widen bench with white stripes on it", "The father is also reading a book, he has blue trousers on, he is reading a red book"; older adults: "the woman is sitting on a park bench reading a yellow book with a plate beside her", "The man is lying on the ground, against a trees, again reading a red book, blue trousers and brown top"). This seems to be in line with previous studies suggesting that older adults tend to rely more on gist-like, broad, and semantic descriptions (Coupland, 2009) when reporting both imagined and current experience (Gaesser et al., 2011).

Furthermore, this tendency to adopt a "gisting" strategy was more evident when older adults described the highly complex pictures (i.e., Gaesser-pictures) than the simpler pictures (i.e., Race-pictures), probably as a means to shape their descriptions in a more coherent and organized way. In contrast, when describing the Race-pictures, young and older adults were equally able to focus on and report each single item depicted in their description. This trend ultimately resulted in an overall greater

amount of details provided when describing the Race-pictures compared to the Gaesser-pictures.

In conclusion, the results of the present study indicate that variances in the visual complexity of the scenes to be described modulate the performance in picture description tasks, as a function of age.

4.3 Experiment 3

4.3.1 Introduction

The results of the Experiment 4.2 seem to favour the interpretation that differences in task demands are, at least partly, responsible for age-related differences in scene description abilities. This raises the possibility that age-related decline in picture description might emerge only when the to-be-described pictures are sufficiently complex to tax the memory or other compromised cognitive functions.

Tentative evidence for this hypothesis comes from a recent study by Romero and Moscovitch (2012) who showed that age-related difficulties in the descriptions of imagined scenarios were especially marked in trials whereby participants had to include a large set of relational (i.e., related to each other and with the imagined context) scenario elements in their descriptions.

Along similar lines, Addis, Musicaro, Pan and Schacter (2010) observed that ageing is associated with a decline in successfully incorporating specific event details (i.e., ‘person, place, and object’) during imagination tasks. In their study, older adults had to recombine 1–3 previously provided items into an event. Age-related decline only emerged in the 3-item condition.

One explanation proposed to account for these observed age-related decline is that when the scene to-be-described becomes sufficiently complex, some elements may be less likely to be integrated due to poor retention of items in long-term memory (Romero & Moscovitch, 2012). This capacity might, for instance, require a system

such as the ‘episodic buffer’ (Baddeley, 2000), which exceeds the capacity of conventional working memory (Baddeley, 2000), and which might affect the ability to monitor what it has been recently said and seen, thereby hampering the use of appropriately nested narrative to supply rich descriptive detail (Zeman et al., 2013).

Based on these assumptions, the current Experiment examined whether or not age-related difficulties in picture description are modulated by the complexity of picture to be described. To address this issue, in this Experiment, the level of visual complexity of the to-be-described pictures was systematically varied. It was hypothesised that age would selectively affect more complex pictures’ description, leaving relatively intact the capacity to describe simpler pictures.

4.3.2 Method

4.3.2.1 Participants

The same twenty-eight participants who entered Experiment 4.1 participated in the study: Fourteen young adults (18 to 35 years old) and fourteen older adults (over 66 years). For details about participants see Experiment 4.1 and Table 4.1.

4.3.2.2 Materials and Procedure

The effects of age and picture complexity on the ability to describe visual scenes were assessed by asking participants to describe four coloured pictures (50 cm x 35 cm) depicting everyday settings. Crucially, these four pictures varied systematically in their level of visual complexity (Level 1 = basic, Level 2 = intermediate, Level 3 = upper intermediate, 4 = complex, see Appendix D). The four pictures were selected from a larger pool of pictures following pilot studies, which involved ten young

undergraduates, and aiming at ensuring that picture complexity categorization was objective and empirically supported.

Participants were shown the four pictures one by one, in a random order, and asked to describe them while inspecting each picture. Participants were instructed to report only what was depicted in the picture without adding any other elements. Again, the first three minutes of the participants' response were considered and scored.

As in the Experiments 4.1 and 4.2, these descriptions were scored according to the criteria by Hassabis et al. (2007). A point was given for each element classed as Spatial Reference (SR), Entities Present (EP), Sensory Descriptions (SD), or Thought/Emotion/Action (TEA), not including repetitions and irrelevant utterances (an example of the scoring procedure can be found in Appendix E). These points were added together to compute an element score for each of the four picture descriptions per participant. These scores were then used in the analysis (one picture description per complexity level).

Additionally, in order to verify that the complexity criteria adopted in the present Experiment were supported by the participants' subjective ratings, participants were also asked to rate, on a 5-point scale, the perceived difficulty of the four pictures previously described. This was done by showing the participants all four pictures again, one by one (see Appendix G).

At the end of the testing session, participants were asked to describe an extra picture (of average complexity level) according to the instructions provided in the previous trial. Immediately after completing this last description, participants engaged in a post-experimental interview in order to ascertain whether they adopted specific strategies in describing the extra picture (see Appendix G).

The study was approved by the local Ethics Committee, and informed consent was obtained from each participant according to the Declaration of Helsinki.

4.3.3 Statistical Analyses

A 4 (Complexity: four levels) X 2 (Age: young adults, older adults) mixed factors analysis of variance (ANOVA) was conducted in order to assess effects of age and picture complexity on picture description. When necessary, post hoc comparisons were conducted using paired t-tests (Level 1 vs. Level 2, Level 2 vs. Level 3, and Level 3 vs. Level 4). In this case, in order to avoid type 1 error accumulation in the planned comparisons, the alpha level was adjusted to 0.016, using a Bonferroni correction, i.e., $0.05/3$ comparisons (3 within-subject comparisons, i.e., between consecutive pairs of complexity level).

4.3.4 Results

A significant main effect of Complexity indicated that participants overall provided more details when describing more complex pictures than simpler ones (see Figure 4.3), $F(3, 78) = 13.08$, $p < .001$, $\eta_p^2 = .33$. There was no significant main effect of Age, $F(2, 26) = 1.81$, $p = .19$, $\eta_p^2 = .065$. However, a significant Age X Complexity interaction was observed, $F(3, 78) = 3.11$, $p < .05$, $\eta_p^2 = .11$.

In order to investigate the effect of picture complexity as a function of age, a series of post-hoc comparisons were conducted within each age-group. In the young adults, there was steady increase in details described from Level 1 ($M = 18.71$, $SD = 5.65$) to Level 2 ($M = 35.5$, $SD = 16.7$), $t(13) = -5.14$, $p < .001$, $\eta^2 = .67$, and a marginally significant increase from Level 2 to Level 3 ($M = 48.64$, $SD = 30.82$), $t(13) = -2.58$, $p = .02$, $\eta^2 = .34$, followed by an unchanged performance from Level 3 to Level 4 ($M = 45.78$, $SD = 31.25$), $t(13) = .41$, $p = .69$, $\eta^2 = .01$. In the older adults' group, there was an increase in the number of details described from Level 1 ($M = 19.71$, $SD = 7.57$) to Level 2 ($M = 34.86$, $SD = 18.5$), $t(13) = -3.68$, $p < .01$, $\eta^2 = .51$, but then their performance remained stable from Level 2 to Level 3 ($M = 33$, $SD = 18.87$),

$t(13) = -.38, p = .76, \eta^2 = .007$, as well as from Level 3 to Level 4 ($M = 29.43, SD = 11.14$), $t(13) = -.77, p = .46, \eta^2 = .022$.

	Level 1	Level 2	Level 3	Level 4
Young adults	18.71 (1.5)	35.5 (4.46)	48.64 (8.23)	45.78 (1.51)
Older adults	19.71 (2.02)	34.86 (4.94)	33 (5.04)	29.43 (2.97)

Table 4.6. Mean numbers (and standard errors) of elements produced in describing pictures of varying complexity as a function of age.

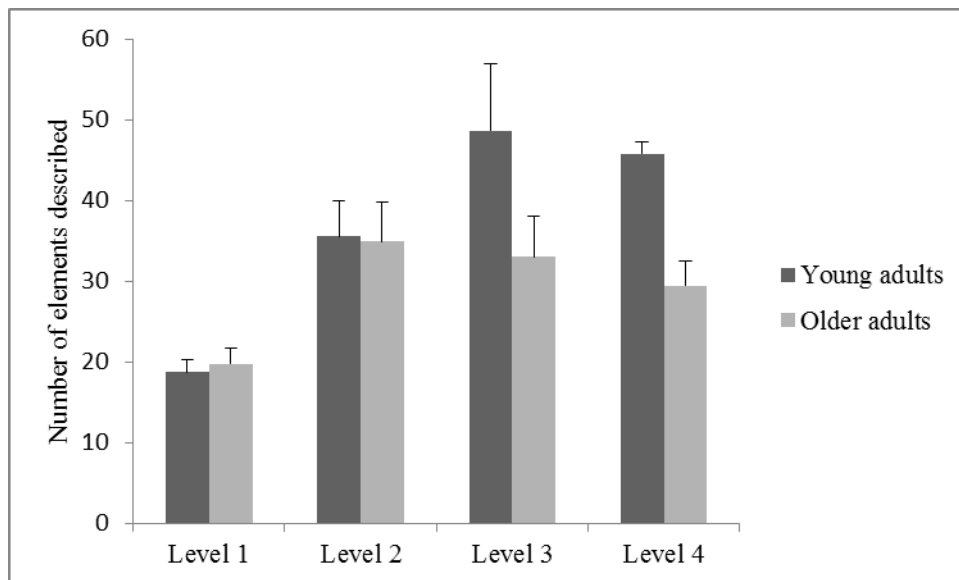


Figure 4.3. Mean number of elements produced in describing pictures of varying complexity as function of age.

4.3.5 Discussion

The present Experiment investigated whether age-related changes in picture description capacities are modulated by the complexity of the scene to be described.

The results revealed that increasing the degree of visual complexity of the pictures resulted in more detailed descriptions up to a certain level, but then caused a drop in the performance, in both age groups. These findings may reflect an increased tendency, when describing the most complex picture (i.e. Level 4), to lump together similar items in broader categories, ignoring minutiae (see also results of Experiment 4.2). This trend ultimately resulted in a smaller number of elements described and, hence, in impoverished descriptions of the most complex picture, regardless of the participants' age.

However, the results of the present Experiment also revealed that, up to a certain level of visual complexity (i.e., Level 3), age-related decline in scene description is modulated by the complexity of pictures to be described. Specifically, ageing selectively affected the description of more complex pictures (i.e., Level 3), leaving relatively intact the capacity to describe the simpler pictures (i.e., Level 1 and Level 2). In particular, while young participants showed a steady increase in details described from Level 1 to Level 3, older adults' performance increased from Level 1 to Level 2, but then remained rather stable.

There are different possible explanations that might account for this result. One possibility is that the older adults' difficulties in describing more complex pictures was due to age-related decline in retention; that is, at higher mnemonic loads, older adults had difficulties retaining all the information over time (Romero & Moscovitch, 2012). In line with this hypothesis, Romero and Moscovitch (2012) showed that the re-coding of retrieved snippets into a unique and coherent scene is an aspect of event construction that might change with age and medial-temporal lobe dysfunction. Results compatible with this interpretation were also obtained by Addis et al. (2010), who documented an age-related deficit in successfully incorporating specific event details during imagination tasks. These findings dovetail nicely with the results of the present Experiment, and suggest that, when a scene becomes sufficiently complex, some items are less likely to be integrated.

Another possible interpretation is that age-related decline in executive control or working memory, as opposed to a long-term memory retention deficit, were the source of older adults' poor performance on more complex pictures (Cabeza, 2002;

Raz, 2000; Velanova, Lustig, Jacoby, & Buckner, 2007). Specifically, it is possible that, under conditions of higher memory load, older adults' performance was affected by a decline in the ability to organize and combine information during the construction task (Simons & Spiers, 2003). This view received support from previous studies, suggesting that working memory resources play a key role in all types of discourse and are used by people to keep track of what they do or say on a moment-to-moment basis (e.g., Caspari & Parkinson, 2000).

A final possible explanation is that general factors, outside the domain of memory, may be responsible for the observed age-related decline (Gaesser et al., 2011). Gaesser et al. (2011) showed that older adults describe complex pictures qualitatively differently from younger adults (see also James, Burke, Austin, & Hulme, 1998; Mackenzie, Brady, Norrie, & Poedjianto, 2007), advancing the possibility that this might be due to differences in narrative styles and communicative goals. For instance, there is a tendency for older adults to rely more on gist-like, broad, and semantic descriptions (Coupland, 2009) and to focus on communication, rather than on accurate description of the story (Harwood, Giles, & Ryan, 1995). However, if differences in narrative styles were the only source of the decreased performance observed with older adults in the present Experiment, one can expect to observe the same impaired performance on both simple and complex pictures. However, this was not found. Therefore, changes in narrative style and communicative goals cannot exclusively account for the observed reduced older adults' performance in pictures' description.

In conclusion, the results of the present Experiment complement previous work (e.g., Gaesser et al., 2011) documenting age-related decline on tasks involving a narrative about a scene and further suggest that these difficulties might be exacerbated by the complexity of the construction.

5 Imagining the present in amnesia: Effects of scene complexity³

5.1 Introduction

While it is well established that long-term memory (LTM) plays a role in remembering the past, recent data suggests that LTM also supports imagination and future thinking (Hassabis & Maguire, 2009; Schacter & Addis, 2009).

An important source of evidence for this hypothesis comes from studies with amnesic patients who, over and above their evident problems in remembering the past, have difficulty in imagining virtual and possible future experiences (e.g., Hassabis et al., 2007; Race et al., 2011; Rosenbaum et al., 2009; Schacter & Addis, 2007; Szpunar, 2010, 2011).

To date, the majority of the studies documenting imagination and future thinking deficits in the context of amnesia have used an open-ended cueing paradigm, emphasizing the creation of detailed imagined scenes/events in response to general cues (e.g., imagine a beach scene, Hassabis et al., 2007; Romero & Moscovitch, 2012). This procedure leaves open the possibility that the observed deficits could be due to reductions in the ability to retrieve the requisite elements from LTM, and/or reductions in the capacity to retain and recombine scene information into a coherent representation (Romero & Moscovitch, 2012).

For instance, LTM deficits may impair the ability to retain and integrate previously mentioned information during the narrative process (Zeman et al., 2013). This ability may require a system such as the ‘episodic buffer’ (Baddeley, 2000), which is thought to be impaired in amnesic patients (Baddeley, 2000; Baddeley & Wilson, 2002) and which may prevent them from remembering what they have recently said

³ An extract of this Chapter is currently under revision in *Neuropsychologia* as “Dewar, M., Neroni, M.A., Zeman, A., Beschin, N., & Della Sala, S., Visual complexity accentuates picture description deficit in amnesia.”

and seen, thereby “hampering the use of appropriately nested narrative to supply rich descriptive details” (Zeman et al., 2013, p. 6).

To address this possibility, Zeman et al., (2013) tested a group of amnesic patients with mixed etiologies and variable neurocognitive profiles on (i) an imagination task, and (ii) a scene description task, in which participants had to describe pictures and real-life settings in detail. They found that the patients produced fewer narrative elements compared to controls, both when describing imagined and current scenarios. This led the authors to propose that a more basic impairment in narrative construction may influence descriptions of imagined and current experience alike (Zeman et al., 2013). However, this hypothesis was challenged by Race, Keane and Verfaellie (2011, 2013), who reported intact picture-description abilities in patients with medial-temporal-lobe amnesia, whose reports of the past and descriptions of imagined future events were impaired.

Zeman et al. (2013) argued that important differences in task demands “hampers direct comparison of the results” across studies. For instance, the use of densely arrayed scenes with similar picture elements in Zeman et al. (2013), compared to the use of very simple drawings in Race et al. (2011, 2013), may have disadvantaged amnesic patients “insofar as more erratic scanning strategies in amnesia (Ryan & Cohen, 2004) may have increased the memory load needed to track which elements had already been mentioned” (Race et al., 2013, p. 1776). These observations raise the possibility that LTM deficits may affect pictures’ description abilities only when the pictures to-be-described are sufficiently complex to tax memory or other compromised cognitive functions.

The present study aimed to further investigate the effect of LTM deficits on scene construction and scene description processes. To this end, a group of ten amnesic patients was tested on the same tasks used in the ageing study reported in Chapter 4. More precisely, participants were engaged in two experimental conditions: (i) a description of imagined experience condition, in which they were required to describe three types of imagined scenarios (i.e. simple a-temporal scenarios, complex a-temporal scenarios and future scenarios), (ii) a picture description condition, in which they were asked to literally describe pictures of varying level of complexity

[i.e., two pictures randomly from the study by Gaesser, Sacchetti, Addis, and Schacter (2011) (highly complex), two pictures randomly from the study by Race, Keane and Verfaellie (2011, 2013) (not very complex), and four additional pictures of increasing level of complexity].

If prospection depends upon narrative construction mediated by LTM related processes, the patients should demonstrate parallel impairments across all the three tasks. Furthermore, if the contrasting results found in Race et al.'s (2011, 2013) and in Zeman et al.'s (2011) studies could be accounted for by differences in task demand, one can expect that LTM deficits would affect more patients' capacity to describe more complex pictures than simpler ones.

5.2 Method

5.2.1 *Participants*

Ten amnesic patients entered the study (three female, range: 27-65 years, mean = 48.7, range = 8-15, mean = 11). Ten control participants (four female, range: 24-65 years, mean = 49; range = 8-16, mean = 11.2) matched for age and education with the patients were also recruited for the study. All patients and controls were right handed. All participants were right handed. Table 5.1 details their demographics, clinical features and neuropsychological test performance.

All patients (and controls) were right handed. Table 5.1 details the patients' demographics, clinical features and neuropsychological test performance.

The patients were selected on the basis of cognitive criteria characterizing the classical amnesic syndrome defined by intact working memory, as assessed via digit span (Carlesimo et al., 1996), but severely impaired long-term memory, as assessed via total immediate word recall, delayed word recall and delayed prose recall (Carlesimo et al., 1996), and corroborated by the patients carers' ratings on the

Clinical Dementia Rating - Everyday Memory Deficits Scale (Katz, Ford, Mokowitz, Jackson & Jaffe, 1963).

Furthermore, specific tests were selected in order to recruit solely patients with (i) normal general intellectual abilities, as assessed via the Raven's Coloured Progressive Matrices (Basso, Capitani & Laiacona, 1987); (ii) spared executive functions, as assessed by the verbal fluency test (Carlesimo, Caltagirone & Gainotti, 1996), the trail making B-A (Giovagnoli, Del Pesce, Mascheroni et al., 1996), and the cognitive estimates (Della Sala, MacPherson, Phillips, Sacco & Spinnler, 2003), (iii) normal visuospatial attention, as assessed by the star cancellation test (Wilson, Cockburn & Halligan, 1987), (iv) normal processing speed, as assessed by trail making A (Giovagnoli et al., 1996) and (v) no language impairments, as assessed by word comprehension, sentence comprehension and picture naming tests (Capasso & Miceli, 2001). All the patients, with the exception of patient P2, showed evidence of extra-amnesic impairment.

Neuroimaging had been performed with CT or MRI for clinical purposes, and therefore the anatomical delineation of lesions lacked details. As indicated in Table 5.1, the lesions involved a number of brain regions including, in some patients, the temporal lobes.

		Patients									
	Cut-off score	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Age		44	41	42	27	64	65	59	44	65	27
Education		8	12	13	8	15	13	13	8	8	12
Aetiology		C	TBI	H	A	H	TBI	I	TBI	SAE	TBI
Lesion site		RT	RFT	RF	RF	RLO	L	RF-PT	AX	LFT-RLP	LFT
Months post onset		24	163	13	3	54	19	13	73	17	124
Coloured Raven Matrix ^a	< 17.5	18	30	31	34	35	22.5	36	36	28	36
Digit span ^b	< 3.5	4	5	5.5	4.75	4.75	3.75	6	5.25	4.25	5.75
Immediate Words Recall ^c	< 28.53	20.8*	16.8*	31.8	23.9*	25.7*	22.3*	28*	9.8*	25*	26.9*
Delayed Words Recall ^d	< 4.69	0*	0*	2.1*	0*	0*	0*	0*	0*	0*	0*
Immediate Prose Recall ^e	< 3.10	1*	4.1	4.7	8	3.4*	1.2*	3.2	1.7*	4.1	4.3
Delayed Prose Recall ^f	< 2.39	0*	0*	0*	0*	0*	2.3*	0*	0*	0*	0*
Words Comprehension ^g	< 18.4	20	20	20	20	20	20	20	20	20	20
Sentences Comprehension ^h	< 11.6	11.8	14	14	14	14	14	14	14	14	14
Pictures Denomination ⁱ	n< 8.2, v< 6.1	nouns=9 verbs=6.9	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10	nouns=10 verbs=10
Verbal Fluency ^j	< 17.35	20.1	48.7	21.5	22.4	31	31	25.8	21	37.9	43.7
Trail Making Test ^m	A > 93 B > 282 B-A=186	NA1	A=35 B=77 B-A=41	A=59 B=150 B-A=91	A=45 B=115 B-A=70	A=45 B=110 B-A=81	A=71 B=124 B-A=50	A=34 B=89 B-A=55	A=36 B=82 B-A=45	A=34 B=181 B-A=172	A=53 B=147 B-A=82
Cognitive Estimates ⁿ	> 18	16.97	19.9*	15.2	17.2	13.2	13.97	17.97	15.97	13.97	17.97
Star cancellation ^o	right/left> 3	right27 left27	right27 left27	right27 left27	right27 left27	right27 left27	right27 left27	right27 left19*	right27 left27	right27 left27	right27 left 27
CDR ^p	range 0-3	2	3*	2	2	3*	2	2	2	2	3*
Activities of daily living ^q	range 0-8	2	2	2	3	6	6	0	1	3	2

Aetiology: A = Angioma, H = haemorrhage, I = ischemia, TBI = traumatic brain injury, C = cyst; Lesion site: F = frontal, P = parietal, O = occipital, T = temporal, AX = axonal damage; Lesion side: L = left, R = right; NA1 = movements impairments; * performance below cut-off score (i.e. abnormal). ^a Coloured Raven Matrix (Basso et al., 1987); ^b Digit Span (Orsini et al., 1987); ^{c,d} Immediate and Delayed words recall (Carlesimo et al., 1996); ^{e,j} Immediate and delayed prose recall; ^g Words comprehension (ENPA, Capasso & Miceli, 2001); ^h Sentences comprehension (ENPA, Capasso & Miceli, 2001); ⁱ Pictures denomination (ENPA, Capasso & Miceli, 2001); ^l Verbal Fluency (FAS, Carlesimo et al., 1996); ^m Trail making test (Giovagnoli et al., 1996); ⁿ Cognitive Estimates (Della Sala et al., 2003); ^o Stars cancellation (Wilson et al., 1987); ^p CDR-Memory Impairment Scale (Morris, 1993); ^q Activities of daily living (Katz, 1963)

Table 5.1. Selected demographic, anatomical and neuropsychological measures for each patient.

5.2.3 *Experimental tasks*

5.2.3.1. Condition 1- Description of imagined scenarios

The procedure originally devised by Hassabis et al. (2007) was adopted to assess participants' ability to describe imagined scenarios. Participants were invited to summon up and describe imagined scenes on the basis of a brief cue read out to them by the experimenter e.g., 'Imagine you are lying on a white sandy beach in a beautiful tropical bay' (Hassabis et al., 2007). Participants were asked to imagine the scene as vividly as they could and to describe it in as much detail as possible. They were asked not to describe specific memories from the past but to create new possible scenarios. A printed text card was placed on the desk in front of them summarizing the main feature of the scenario, to act as a reminder if needed.

As in Experiment 4.1, the materials consisted of nine scenarios: Three scenarios involving everyday settings - *complex a-temporal scenarios* (a beach, a museum and a market, taken from Hassabis et al., 2007), three scenarios involving constrained settings – *simple a-temporal scenarios* (a lift, a fitting room and a cubicle in a call centre) and three scenarios requiring 'episodic future thinking' – *future scenarios* (a possible Christmas event, a possible event in the next weekend, a possible future meeting with a friend, taken from Hassabis et al., 2007) (see Appendix D).

It was ensured that participants maintained the goal of the task throughout. The participants' descriptions were recorded and later transcribed. As in the Experiment 4.1, the first three minutes of the participants' responses were considered and scored.

The participants' descriptions were scored according to the criteria of Hassabis et al. (2007). A point was given for each element that depicted either Spatial Reference (SR), Entities Present (EP), Sensory Descriptions (SD), or Thought/Emotion/Action (TEA). Repetitions and irrelevant utterances were not included in the score (for an example of the scoring procedure see Appendix E). For each participant, a mean element score was computed for each scenario type (complex a-temporal scenarios,

simple a-temporal scenarios, future scenarios) by averaging the total number of elements described across each scenario.

In their original study, Hassabis et al. (2007) computed a composite score, the ‘experiential index’. This score measures the overall richness of the imagined experience and is obtained by calculating and combining four subcomponent measures: Content analysis by the experimenter, self-ratings of presence and salience, self-ratings of spatial coherence, and independent rating of quality. In order to derive this score, Hassabis et al. (2007) asked all participants to rate their descriptions subjectively after completion of their last scene description. This, however, imposes a memory load as participants have to remember their earlier descriptions following a (filled) delay. In order to minimize such memory load and to obtain an experiential index for a specific scene, an extra imagination trial was added at the end of the imagination condition. More precisely, participants were asked to summon up and describe a pub scene (Hassabis et al., 2007) according to the instructions provided in the previous trial. Immediately after completing their description of the imagined pub scene, participants were asked to provide self-ratings of (i) presence and salience, and of (ii) spatial coherence for this scene. This pub description was subsequently score using Hassabis et al.’s (2007) ‘experiential index’.

5.2.3.2 Condition 2- Description of pictures

5.2.1.1.1 Description of pictures previously used by Race et al. (2011) and Gaesser et al.(2011).

Participants’ ability to describe visually presented pictures was assessed by asking them to describe two sets of two pictures, which have been used recently in related work and that were judged, on the basis of results from previous studies, to differ in complexity (see Zeman et al., 2013): Two pictures selected randomly from the study by Gaesser et al. (2011) (highly complex) and two pictures selected randomly from

the study by Race et al. (2011) (not very complex). The pictures are shown in Appendix D.

Participants were shown the four pictures one by one, in a random order, and asked to describe them while inspecting each picture. Participants were instructed to report only what was depicted in the picture without adding any other elements. In order to align the present study more closely with Gaesser et al.'s (2011) and Race et al.'s (2011) studies, only the first three minutes of each description were considered and scored. Participants' descriptions were analysed according to the criteria of Hassabis et al. (2007) by computing a score for each of the four picture descriptions, per participant.

Finally, in order to verify that the presumed different complexity of the two sets of pictures was supported by the participants' subjective ratings, they were asked to rate, on a 5-point scale, the perceived complexity of the two sets of pictures previously described. This was done by showing the participants all four pictures, again, one by one, following the main task (see Appendix H).

5.2.1.1.2 Description of pictures of varying complexity

The effect of picture complexity on the ability to describe visual scenes was assessed by asking participants to describe four colour pictures (50 cm x 35 cm), which depicted everyday settings and varied systematically in their level of visual complexity (Level 1 = basic, Level 2 = intermediate, Level 3 = upper intermediate, 4 = complex, see Appendix D). The four pictures were selected from a larger pool of pictures following pilot studies, which involved ten undergraduates, and aiming at ensuring that picture complexity categorization was objective and empirically supported (see Experiment 4.3).

Participants were shown the four pictures one by one, in a random order, and asked to describe them while inspecting each picture. Participants were instructed to report only what was depicted in the picture without adding any other elements. As in the previous conditions, the first three minutes of the participants' response were

considered and scored. These descriptions were scored according to the criteria by Hassabis et al. (2007). These scores were in the analysis (one picture description per complexity level).

Additionally, in order to verify whether the complexity criteria adopted in the present study were supported by the participants' subjective ratings, they were asked to rate, on a 5-point scale, the perceived difficulty of the four pictures previously described. This was done by showing the participants all four pictures again, one by one (see Appendix H).

At the end of the testing session, participants were also asked to describe an extra picture (of average complexity level) according to the instructions provided in the previous trials. Immediately after completing this last description, participants engaged in a post-experimental interview in order to ascertain whether they adopted specific strategies in describing the extra picture (see Appendix H).

5.2.1.2 Semantic test

In order to rule out the possibility that patients' performance in the picture description tasks may be affected by semantic LTM difficulties, as opposed to a more general deficit in narrative construction, participants engaged in a 'semantic test' consisting of naming various items depicted in the pictures. To this end, five pictures were selected from the previously presented materials (i.e., one Race et al.'s picture, one Gaesser et al.'s picture and three pictures of varying level of complexity), and participants were asked to name, one by one, all the items pointed out by the experimenter (according to pre-established order and categorization). This semantic test took place after the test assessing description of pictures of varying complexity.

5.2.1.3 Subjective measure of visual imagery abilities

Following all tasks described above, the Test of Visual Imagery Control (TVIC, Gordon, 1949; Richardson, 1969) and the Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973) were administered in order to assess participants' subjective appraisal of their imagery abilities. The TVIC assesses the ability to form and modify a visual image, using 10 questions scored on a 5-point rating scale, yielding a maximum score of 50. The VVIQ contains 16 items rating the vividness of evoked visual images, each scored on a 5-point scale, yielding a maximum score of 80.

The study was approved by the local Ethics Committee, and informed consent was obtained from each participant according to the Declaration of Helsinki.

5.3 Statistical Analyses

In the Description of imagined experience condition, two mixed factors analyses of variance (ANOVAs) were conducted in order to assess the effects of group and scenario complexity on the participants' capacity to describe imagined scenes. In particular, a 2 (Scenario: complex a-temporal scenarios, simple a-temporal scenarios) X 2 (Group: patients, controls) ANOVA was conducted in order to assess the effect of scenario type and group on the ability to describe imagined scenes. As in the previous ageing study (Chapter 4, Experiment 4.1), an additional 2 (Scenario: complex a-temporal scenarios, future scenarios) X 2 (Group: patients, controls) ANOVA was conducted to separate the contribution of prospection abilities and related cognitive functions in constructing mental scenarios. When necessary, post-hoc comparison contrasted the relevant experimental conditions. Additionally, independent t-tests comparisons were used to compare the groups on number of irrelevant utterances and repetitions and on the experimental index (Hassabis et al., 2007).

In the Description of pictures condition, two sets of analyses were carried out to compare the groups' performance on the two pictures description tasks.

First, a 2 (Picture type: Race-pictures, Gaesser-pictures) X 2 (Group: patients, controls) mixed factors ANOVA was conducted in order to assess the effects of group and pictures type (Race-pictures vs, Gaesser-pictures) on pictures descriptions. Whenever appropriate, post-hoc comparisons contrasted the relevant experimental conditions.

Secondly, a 4 (Complexity: four levels) X 2 (Group: patients, controls) mixed factors analysis of variance (ANOVA) was conducted in order to assess effects of group and picture complexity on pictures description. Post-hoc comparisons were conducted using independent t-tests (between groups at each complexity level) and paired t-tests (Level 1 vs. Level 2, Level 2 vs. Level 3, and Level 3 vs. Level 4). In order to avoid type 1 error accumulation in the post-hoc comparisons, alpha level was adjusted to 0.016, using a Bonferroni correction, i.e., $0.05/3$ comparisons (3 between-subjects comparisons, i.e., one at each complexity level; 4 within-subject comparisons, i.e., between consecutive pairs of complexity level).

Finally, independent t-tests comparisons were used to compare patients and controls on the measures of visual imagery.

5.4 Results

5.4.1 Condition 1- descriptions of imagined experience

5.4.1.1 Details reported

A 2 (Scenario: complex a-temporal scenarios, simple a-temporal scenarios) X 2 (Group: patients, controls) mixed factors analysis of variance (ANOVA) revealed a significant main effect of Group, $F(1, 18) = 25.88$, $p < .001$, $\eta_p^2 = .59$, indicating that patients, overall, reported significantly less than did controls (see Table 5.2 and Figure 5.1). However, no significant main effect of Scenario, $F(1, 18) = .49$, $p = .49$, $\eta_p^2 = .03$, or a significant Scenario X Group interaction, $F(1, 18) = .19$, $p = .67$, $\eta_p^2 = .01$, were observed.

The additional 2 (Scenario: complex a-temporal scenarios, future scenarios) X 2 (Group: patients, controls) ANOVA showed a significant main effect of Group, $F(1, 18) = 19.38$, $p < .001$, $\eta_p^2 = .52$ (see Table 5.2 and Figure 5.1). Again, no significant main effect of Scenario, $F(1, 18) = .59$, $p = .45$, $\eta_p^2 = .03$, or a significant Group X Scenario interaction, $F(1, 18) = .05$, $p = .83$, $\eta_p^2 = .003$, were observed.

	Simple a-temporal scenarios	Complex a-temporal scenarios	Future scenarios
Patients	3.63 (1.4)	5.48 (1.54)	4.3 (1.46)
Controls	25.57 (3)	26 (5.17)	23.9 (4.4)

Table 5.2. Mean number (and standard errors) of elements produced in describing imagined experience as a function of group.

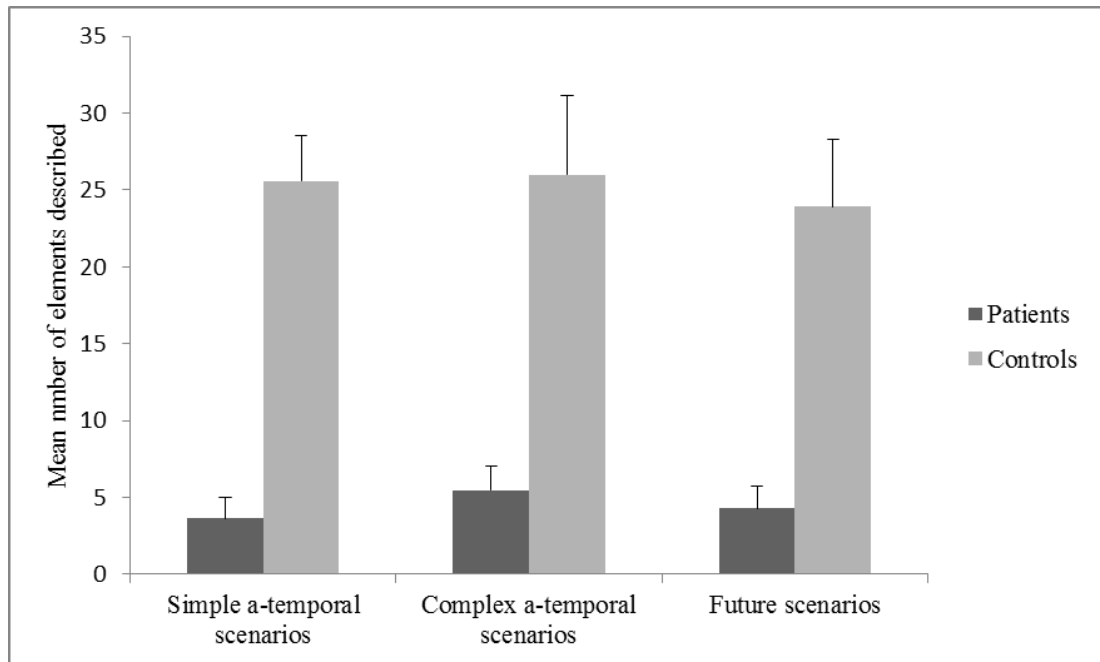


Figure 5.1. Mean number of elements produced in describing imagined experience as a function of group. Error bars = Standard errors.

5.4.1.2 Irrelevant utterances and repetitions

The patient group produced more irrelevant utterances and repetitions than the control group when describing the simple a-temporal scenarios, $t(18) = 2.24$, $p < .05$, $\eta^2 = .22$ (patients: $M = 3.95$, $SD = 2.69$; controls: $M = 1.9$, $SD = 0.34$), the complex a-temporal scenarios, $t(18) = 2.09$, $p = .05$, $\eta^2 = .19$ (patients: $M = 5.25$, $SD = 1.1$; controls: $M = 2.73$, $SD = 0.48$), and the future scenarios, $t(18) = 3.34$, $p < .005$, $\eta^2 = .38$ (patients: $M = 8.27$, $SD = 1.42$; controls: $M = 3.03$, $SD = 0.67$).

	Simple a-temporal scenarios	Complex a-temporal scenarios	Future scenarios
Patients	3.95 (.85)	5.25 (1.1)	8.27 (1.42)
Controls	1.9 (.34)	2.73 (.48)	3.03 (.67)

Table 5.3. Mean number (and standard errors deviations) of irrelevant utterances and repetitions produced in describing imagined experience as a function of group.

5.4.1.3 The experiential index

Patients and controls significantly differed on the experimental index, $t(18) = -6$, $p < .001$, $\eta^2 = .67$. Additional analyses showed that patients described significantly fewer elements than controls (i.e., content) $t(18) = -4.95$, $p < .001$, $\eta^2 = .58$, and reported significantly lower scores in the quality judgement index, $t(18) = -4.69$, $p < .001$, $\eta^2 = .55$. No significant group differences were observed for the sense of presence, $t(18) = -1.07$, $p = .30$, $\eta^2 = .06$, the perceived salience, $t(18) = -1.18$, $p = .25$, $\eta^2 = .07$, and the spatial coherence, $t(18) = -.25$, $p = .80$, $\eta^2 = .003$.

	Content	Sense of presence	Perceived salience	Spatial coherence	Quality rater	Experimental Index
Patients	5.5 (1.74)	3.7 (.49)	3.5 (.45)	5.3 (.54)	3.3 (.84)	20.4 (2.13)
Controls	28.6 (4.33)	4.3 (.26)	4.1 (.23)	5.5 (.58)	8.3 (.65)	50.8 (4.59)

Table 5.4. Mean scores (and standard errors) on the different subcomponents of the experimental index (Hassabis et al., 2007), as a function of group.

5.4.2 Condition 2-description of pictures

5.4.2.1 Description of pictures previously used by Race et al. (2011) and Gaesser et al. (2011)

A 2 [Pictures type: Race-pictures (not very complex), Gaesser-pictures (highly complex)] X 2 (Group: patients, controls) mixed factors ANOVA revealed a significant main effect of Picture type, $F(1, 18) = 19.88$, $\eta_p^2 = .52$, $p < .001$, indicating that participants overall described more details in the Race-pictures (not very complex) than the Gaesser-pictures (highly complex). A significant main effect of Group was also observed, $F(1, 18) = 27.82$, $p < .001$, $\eta_p^2 = .61$, showing that controls described more elements than did the patients in both sets of pictures (see Table 5.5). No a significant Picture type X Group interaction was found, $F(1, 18) = .05$, $p = .82$, $\eta_p^2 = .003$.

	Race-pictures	Gaesser-pictures
Patients	17.35 (3.24)	5.85 (1.25)
Controls	62.2 (6.93)	51.8 (10)

Table 5.5. Mean number (and standard errors) of elements described in the Race-pictures and in the Gaesser-pictures as a function of group.

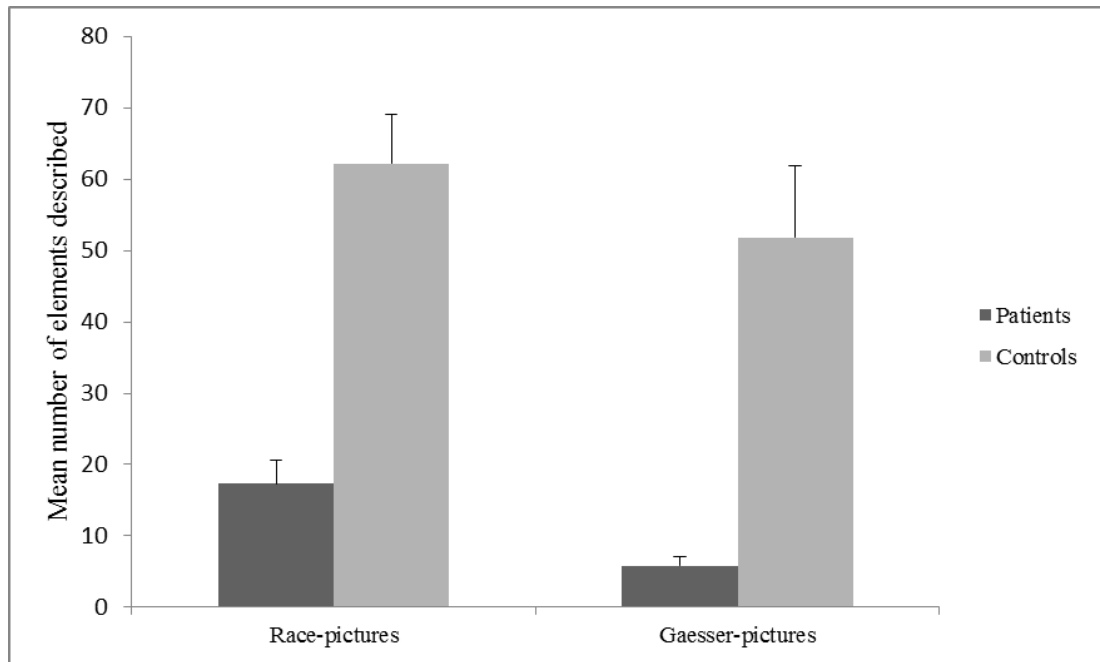


Figure 5.2. Mean number of elements described in the Race-pictures and in the Gaesser-pictures as a function of group. Error bars = Standard errors.

5.4.2.2 Description of pictures of varying complexity (number of details described)

A 4 (Complexity: four levels) X 2 (Group: patients, controls) mixed factors ANOVA revealed a significant main effect of Complexity, $F(3, 54) = 6.73$, $p = .001$, $\eta_p^2 = .27$, indicating that participants, overall, provided more details when describing more complex pictures than simpler ones. A significant main effect of Group, $F(1, 18) = 34.18$, $p < .001$, $\eta_p^2 = .65$, also showed that controls described overall more elements than did the patients. Finally, a significant Complexity X Group interaction, $F(3, 54) = 5.46$, $p < .005$, $\eta_p^2 = .23$ was observed.

In the control group, the number of elements described increased significantly from Level 1 to Level 4, $t(9) = 4.311$, $p < .005$. This was not the case in the patients' group, $t(9) = .638$, $p = .539$, in which the number of elements described increased from Level 1 to Level 2, $t(9) = 2.627$, $p = .027$ (not significant at $\alpha = .0125$) but then decreased from Level 2 to Level 3, $t(9) = -2.596$, $p = .029$ (not significant at $\alpha = .0125$) (see Figure 5.3). Examination of individual patients' data (see Figure

5.4) revealed that only one patient (patient P4) showed a sizeable increase in the number of elements described ($N = 23$) between Level 1 and 4.

Finally, additional post-hoc comparison revealed that, overall, the control group described significantly more elements than did patients at Level 1, $t(18) = -6.24$, $p < .001$, $\eta^2 = .68$, Level 2, $t(18) = -5.74$, $p < .001$, $\eta^2 = .65$, at Level 3, $t(18) = -4.13$, $p = .001$, $\eta^2 = .49$, and at Level 4, $t(18) = -4.8$, $p < .001$, $\eta^2 = .56$.

	Level 1	Level 2	Level 3	Level 4
Patients	7.1 (.6)	12.6 (2.16)	8.1 (1.61)	8.7 (2.44)
Controls	20.3 (2.3)	37.3 (3.72)	45.4 (8.89)	45.3 (7.22)

Table 5.6. Mean number (and standard errors) of elements produced in describing pictures of varying complexity as a function of group.

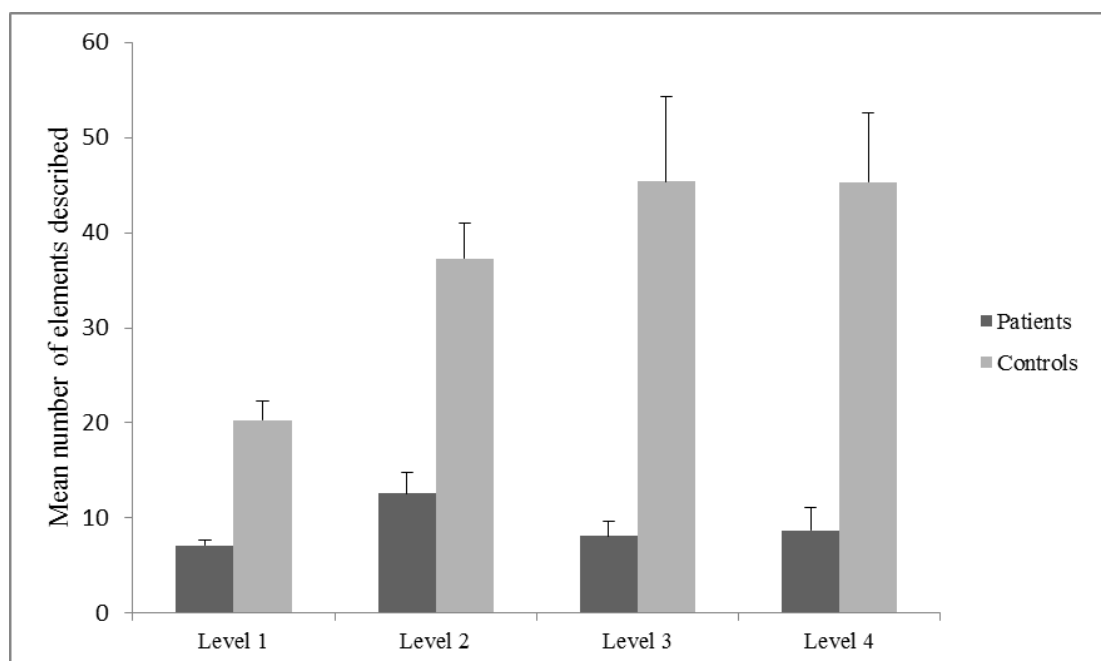


Figure 5.3. Mean number of elements produced in describing pictures of varying complexity as a function of group. Error bars = Standard errors.

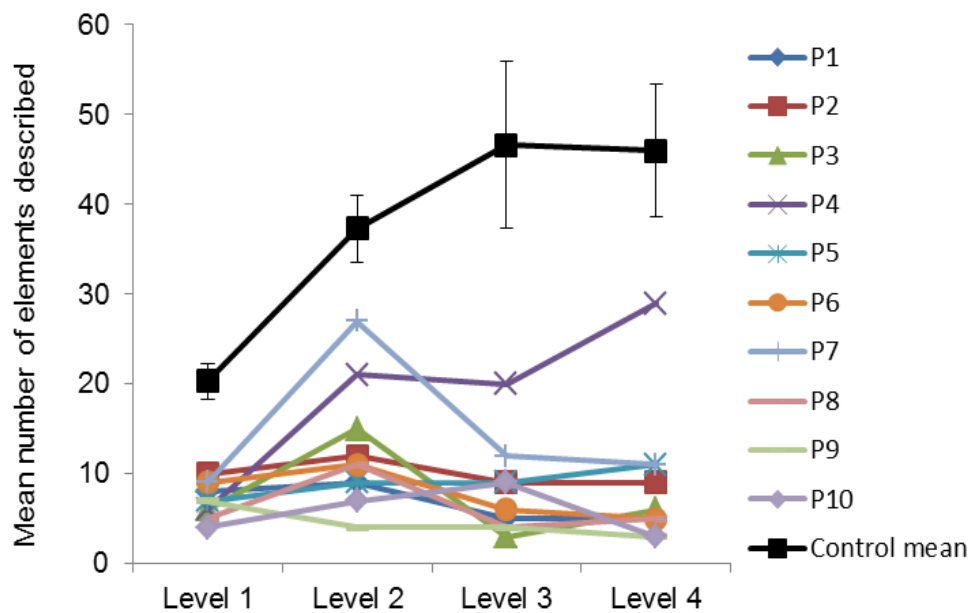


Figure 5.4. Number of picture elements described by each amnesic patient and by the control group (group mean) as a function of picture complexity (Level 1 = simple, Level 4 = very complex; all pictures are provided in the Supplemental Materials). Only one patient (P4) performed as well as the average control. Error bars = Standard errors.

5.4.3 Association between neuropsychological test scores and descriptions of complex pictures (patients only)

There was a significant correlation between the scores on the picture description task and the scores on the immediate prose recall test ($r=.728$, $p=.017$; non-significant when adjusting for multiple comparisons with alpha level = .0036). No other correlations between picture description scores and neuropsychological test scores were significant (all $p > .397$).

5.4.4 Semantic test

Participants performed at ceiling in the semantic test. In fact, 100% of the items were appropriately named by both the patients and the controls.

5.4.5 Subjective measures of visual imagery abilities

The mean scores in the TVIC and in the VVIQ are presented in Table 5.7. Patients and controls did not significantly differ in the TVIC, $t(18) = -.33$, $p = .74$, $\eta^2 = .006$, or in the VVIQ, $t(18) = -1.8$, $p = .09$, $\eta^2 = .15$.

	VVIQ	TVIC
Patients	65.8 (1.7)	49.9 (3.73)
Controls	69.5 (1.15)	51.4 (2.37)

Table 5.7. Mean scores (and standard errors) in the subjective measures of visual imagery abilities as function of group.

5.5 Discussion

This study investigated whether impaired imagination and prospection in amnesia may reflect, at least in part, deficits in LTM processes supporting narrative construction.

In line with previous investigations (e.g., Hassabis et al., 2007), the results of the present study showed that amnesic patients were impaired at constructing detailed narratives about imagined events, whether a-temporal or future.

Moreover, the present study replicated the finding that the experiential index is overall lower in amnesic patients than in controls (Hassabis et al., 2007). However, contrary to Hassabis et al. (2007), the spatial coherence index did not differ between the two groups. A possibility is that patients' poor metamemory abilities (Parkin, Bell, & Leng, 1988; Seelye, Schmitter-Edgecombe, & Flores, 2010; Shimamura & Squire, 1986) may have led them to overestimate the spatial coherence of their own descriptions. This was also confirmed by the judgements given by an external rater on the quality of the participants' descriptions (i.e., quality judgment index), which was significantly lower for patients compared to controls. Thus, overall, the present results seem to favour the interpretation that episodic LTM is particularly important for constructing event representations that are both detailed and specific (Romero & Moscovitch, 2012).

Nevertheless, no effect of complexity or complexity x group interaction were observed in the imagined scenario task. That is, the controls provided an equally high number of elements for the simple and complex scenarios. This might be the result of methodological limitations rather than of a dissociation between the effects of complexity on descriptions of imagined and in-view scenes. Indeed, although the overall context of the scenario to be imagined (e.g. an elevator) was constrained, constraints were imposed on its content (i.e., there was not a constraint on the number of elements to be included in the scenarios' description). Recent work by Romero and Moscovitch (2012) suggests that a complexity effect is in fact observed in controls in imagination tasks when complexity is controlled more tightly. Romero and Moscovitch (2012) provided participants with a set number of elements to be included in their scenarios. In keeping with our complexity findings in the picture description task, they showed that imagined scene description deficits in amnesic patients were especially marked in trials in which participants had to include a large set of relational scenario elements in their descriptions.

Importantly, patients' deficits in describing imagined scenarios cannot be entirely attributed to an inability to access details from episodic memories of similar experiences. Indeed, it was observed that patients' deficits in imagination and future

thinking also extended to tasks requiring them to describe pictures which were currently in view.

It is of note that, contrary to what was observed with older adults in the ageing study reported in Experiment 4.3, in the present study, controls outperformed the patients in the description of even the simplest pictures (e.g., Race-pictures and Level 1). It is likely that, although relatively simple, these pictures were sufficiently complex to tax picture description ability in amnesic patients, and thus that more simple pictures are needed for patient performance to be on par with that of controls.

This notwithstanding, the present results suggest that the complexity of to-be-described pictures can determine whether or not a (substantial) picture description deficit is observed in amnesic patients. This effect of picture complexity might account for the previously observed variations in the degree of difference between patients and controls in picture description (Race et al., 2011; 2013, Zeman et al., 2013). However, in the absence of a replication of the present findings in the patient group by Race et al., (2011; 2013) it remains possible that Race's patients simply did not have picture description deficits, perhaps due to their restricted medial temporal lobe (MTL) lesions (Race et al., 2013; Zeman et al., 2013).

How might LTM deficits hamper picture description in those patients showing such impairment? Given the hypothesised association between the LTM system and complex visual discrimination (Graham, Barense & Lee, 2010), it is possible that impairment of the LTM system hampered perceptual discrimination/experience. Although this account cannot be ruled out via the data at hand, the patients' normal performance on two perceptually demanding tests - the Raven's Coloured Matrices and Star Cancellation (see Table 5.1) - is suggestive of normal perceptual abilities in our patients' sample.

It is also unlikely that the picture description deficit was the result of impaired retrieval of element names from semantic LTM, given that all patients were able to (i) name correctly all picture elements pointed out to them in the semantic control test and (ii) perform normally in a standard picture naming test (see Table 5.1). This finding resonates with the cognitive profile of the amnesic patient KC, who, although

impaired in the description of familiar stories, had intact knowledge of story details, as assessed via a story recognition test (Rosenbaum et al., 2009).

It has been proposed that picture description deficits in amnesia are associated with impairment of a temporary episodic LTM system such as the episodic buffer (Zeman et al., 2013), which is thought to be impaired in many patients with amnesia (Baddeley & Wilson, 2002). Such impairment could prevent patients from integrating and maintaining picture elements and recent descriptions (Romero & Moscovitch, 2012), thus hampering their ability to construct complex ‘nested’ narrative (Romero & Moscovitch, 2012; Zeman et al., 2013). Previous research suggests that the episodic buffer is necessary for immediate recall of prose (Baddeley, 2000; Baddeley & Wilson, 2002). Interestingly, patient P4, who was the only patient to show a reliable effect of picture complexity (increase by 23 elements, see Figure 5.4) and good performance in the imagination task, also had the highest score amongst the patient group in immediate prose recall (score = 8, see Table 5.1). Given that this patient’s delayed recall for words and for prose was at floor (0), her spared ability in the aforementioned tasks cannot be accounted for by an overall milder amnesia. Although this parallel sparing of immediate prose recall and picture/imagined scenario description ability in a single patient needs to be treated tentatively, it supports the hypothesis that description of complex scenarios requires intact/spared episodic buffer functions (Zeman et al., 2013).

There is also the possibility that subtle deficits in executive functions, in particular organisational ability, could have impeded patients’ picture description performance. However, their normal performance on three executive function tests – verbal fluency, trail making and cognitive estimates (except P2) - is suggestive of normal executive function ability in our patients’ sample. Moreover, there were no significant correlations between the performance on these tests and the picture description task. In fact, only one patient (P4) was able to describe the complex pictures in any detail, and her executive function scores fell within the lower to middle portion of the patients’ score range (see Table 5.1). This cognitive profile would not be predicted by an executive function account of the picture description deficit. However, it is worth noticing that the present study did not assess

organisational ability specifically and, therefore, a potential contribution of organisational deficits to the observed picture description deficit cannot be ruled out via the data at hand.

In conclusion, the results of the present study strengthen the hypothesis that both the reduction in details of picture description observed with age (Chapter 4) and the reduction in the context of amnesia may reflect higher-order processes related to narrative construction underlying the description of both imagined and current experience. Furthermore, and importantly, they suggest that whereas basic narrative can be constructed via non-LTM cognitive processes, the construction of complex narrative depends upon intact functioning of some aspects of episodic LTM. While the data point towards a temporary LTM/episodic buffer account, the precise cognitive and anatomical basis of such LTM-associated narrative construction remains to be established via future research.

Third Part

On the functional relevance of prospection in everyday life.

The ability of foreseeing unique episodes and of acting accordingly provides humans with an essential selective advantage. Through the ability to preview the future, people can anticipate how best to think, feel and act in just about any conceivable setting (Gilbert & Wilson, 2007, 2009; Suddendorf & Corballis, 2007). As Bar (2007) noted, “we simulate, plan and combine past and future in our thoughts, and the result might be ‘written’ in memory for future use” (p. 286). Thus, imagining hypothetical future events can be used to anticipate and guide future-oriented behaviour.

Consistent with these assumptions, research has shown that prospection represents a frequently occurring mental phenomenon and supports a range of adaptive behaviours from planning to decision making, to self-control and the construction of a sense of identity (Atance & O’Neill, 2001; Boyer, 2008; Damasio, 1999; Schacter, Addis, & Buckner, 2008; Szpunar, 2010). In particular, as also discussed in the Introduction, it has been recently proposed that one of the primary functions of mentally simulating specific future events (and, in particular, near-future events) is to implement mental simulations of action plans leading to goal attainment (D’Argembeau et al., 2011). This seems to suggest the existence of a close relationship between episodic future thinking (EFT, the “episodic” form of prospection referring to the simulation of temporally and contextually specific future events) and another well-known future-oriented process, which explicitly refers to the ability to remember and carry out intended activities in the future, prospective memory (PM). Nevertheless, to date, the relationship between these two future-oriented processes has been often given for granted and not fully investigated.

The last part of this dissertation aims at providing new insights into the functional benefits that may arise from future simulation in everyday life by investigating the existence of a possible interplay between EFT and PM. Accordingly, it will first introduce the concept of PM and briefly review the main literature in this field. Then, a few recent findings will be highlighted pointing towards a possible casual role of EFT in aiding prospective remembering.

An overview on prospective memory research

Prospective memory is defined as remembering to perform an intended action at a future point in time (Brandimonte et al., 1996; Ellis & Freeman, 2008). Everyday examples of prospective memory include remembering to buy bread on the way home from work, remembering to give friends a message upon next encountering them, and remembering to take medication.

It is commonly accepted that carrying out a prospective memory action consists of several phases, which involve distinct cognitive processes (Brandimonte et al., 1996). First, the intention to perform an action at a later time is formed (i.e., encoding). This phase is followed by a period of delay, which can vary from minutes to weeks, months or years, during which the intention is stored while one or more ongoing activities are performed (i.e., intention retention). When the appropriate opportunity is encountered, the intended action is retrieved and executed on one's own initiative (i.e., intention retrieval and execution). Finally, some form of evaluation of the outcome is needed to avoid unnecessary repetitions of fulfilled intentions or to ensure future success of failed intentions (i.e., output monitoring, Ellis, 1996).

Thus, any PM task involves two components: a retrospective component, referring to the recollection of the intention, and a prospective component, referring to the self-initiated retrieval of the intention at the appropriate moment and its execution (Einstein, Holland, McDaniel, & Guynn, 1992; Smith & Bayen, 2006).

Most of the studies targeting prospective memory have implemented laboratory-based PM tasks, following the paradigm originally developed by Einstein and McDaniel in 1990. Specifically, in such laboratory-based studies participants are primarily engaged in a continuous cognitive task (ongoing task, such as memorizing a list of words or performing a categorization task) while, at the same time, they have to remember to do an action at the appropriate moment (e.g. press a key when a specific word occurs or at a specific point in time). That is, the paradigm takes the form of a dual-task, with a primary, ongoing task that serves as a covering task for the prospective task.

Besides these laboratory studies, some authors have applied naturalistic PM tasks involving the execution of intended actions in everyday life, such as remembering to keep appointments, to mail cards to the experimenter, or to log the time on an electronic device (e.g., Marsh, Hicks, & Landau, 1998; Rendell & Thomson, 1999).

According to the type of target cue that signals the retrieval of the intended action, researchers typically distinguish among three main types of prospective memory tasks: (1) those that are event-based (i.e., performing an action when a specific target event occurs in the environment, such as remembering to pass on a message to a coworker at a future meeting), (2) those that are time-based (i.e., carrying out an action at a certain time or after a certain amount of time has elapsed, such as remembering to attend a meeting at a particular time or to take cookies out of the oven in 20 minutes), and (3) those that are activity-based (i.e., performing an intended action after the completion of another activity, such as to take medication after a meal).

In the last few years, one of the most debated issues in the prospective memory literature has concerned the mechanisms underlying intention retrieval and, in particular, the nature of processes involved in monitoring whether an action needs to be performed (e.g., Einstein & McDaniel 2005; Kliegel, McDaniel, & Einstein, 2008). Two main theoretical perspectives have been proposed in the attempt to explain whether or not the retrieval of a delayed action involves some additional cognitive resources (attention and working memory). According to one of such accounts, known as “reflexive-associative theory”, at least on some occasions, the

intention may be retrieved through a reflexive associative process that involves few, if any, limited cognitive resources (e.g., Brandimonte, Ferrante, Feresin, & Delbello, 2001; McDaniel, Guynn, Einstein, & Breneiser, 2004). This corresponds to people's introspective impression that sometimes intended actions "pop into mind" (Einstein & McDaniel, 1990). In direct contrast, the Preparatory Attentional and Memory Theory (PAM, Smith, 2003) states that a successful prospective memory performance always requires the allocation of attentional resources to correctly recognize the appropriate moment to initiate the intended action (e.g., Smith, 2003; Smith & Bayen, 2004).

Currently, the preponderance of evidence supports the multiprocess theory (McDaniel & Einstein, 2000), which assumes that the retrieval of an intention may be either an automatic or an attention demanding, strategic process depending on the characteristics of the prospective memory task (Kliegel, Martin, McDaniel, & Einstein, 2001; 2004; Brandimonte, Ferrante, Bianco, & Villani, 2010), of the target distinctiveness and familiarity (Brandimonte & Passolunghi, 1994; McDaniel & Einstein, 1993; Uttl, 2005) and of the degree of association of the target with the intended action (e.g., McDaniel & Einstein, 2007). In particular, prospective memory is thought to rely on a reflexive retrieval mechanism when at least one of three conditions is encountered: (i) the cue and target action are highly associated with each other, (ii) the cue is salient, (iii) the other processes performed during the period between cue and action of the prospective memory task direct attention to relevant cue features (e.g., task appropriate processing).

Relative to the greater amount of studies focusing on the investigation of the different conditions under which an intention can be retrieved, relatively little research has investigated how an intention is encoded and the potential impact of this on the retrieval (Dismukes, 2010). To this regard, an important exception comes from a subfield of prospective memory research, namely, the study of implementation intentions (Gollwitzer, 1993), which has extensively documented that, although forming an intention does not necessarily require one to think about that event in a specific manner (Szpunar & Tulving, 2011), when people encode an intended action with respect to the specific future context in which they will execute

it (e.g., saying ‘If situation X occurs, then I will do Y’), their chances of carrying out that intention increase significantly (e.g., Gollwitzer, & Sheeran, 2006). Studies on implementation intentions, therefore, revealed that the way in which an intention is formed and encoded may be extremely relevant to successfully remember and carry out a prospective action and highlight a need for future research to identify and develop new strategies and/or cognitive processes which may bolster prospective remembering.

Can episodic future thinking facilitate prospective remembering?

Schacter, Addis and Buckner (2008) and Szpunar (2010) stated that, although a mental simulation of the future need not necessarily accompany the formation of an intention, there is reason to believe that EFT may come into play in PM tasks. In particular, it has been suggested that EFT may aid prospective remembering by linking an intention to the mental representation of a specific context that can later cue the intention, thus improving the realisation of the prospective action.

Initial support for this hypothesis comes from a few recent studies suggesting that future simulation may serve as an encoding strategy able to enhance PM (e.g., Brewer et al., 2011). For example, Brewer and Marsh (2010) found that when a future context is simulated at encoding, intentions are more likely to be fulfilled, and Paraskevaides, Morgan, Leitz, Bisby, Rendell, and Curran (2010) observed that future events simulation can overcome even alcohol-induced deficits in prospective memory. Furthermore, Poppenk, McIntosh, Craik, and Moscovitch (2010) provided evidence that prospective memory encoding is supported by both a common episodic memory network and an executive network specifically recruited by future-oriented processing.

Although these initial findings suggest interesting avenues for the investigation of the potential relationship between EFT and PM, as they stand, they are inconclusive as to the role that EFT may play in aiding prospective remembering.

Based on these assumptions, this part of the thesis aimed at empirically assessing to what extent and under which circumstances EFT facilitates prospective remembering.

In Chapter 6, the functional relevance of EFT on PM is investigated by assessing whether simulating the future context associated to a delayed action may increase prospective remembering and to what extent this aiding effect depends on a match between the mentally simulated future task and the actual executed task.

In Chapter 7, four experiments are presented aiming at exploring the source of the potential beneficial effect of EFT on PM.

6 Does episodic future thinking improve prospective remembering? ⁴

6.1 Introduction

In 2007, Suddendorf and Corballis acknowledged that, in a dynamic world, predicting future situations can provide a selective advantage (see also Bar, 2009). People are indeed prone to use future simulations as a basis for predictions across a range of situations, such as planning, problem solving, decision making and related forms of goal directed processing (e.g.; D'Argembeau et al., 2011).

Research in health psychology also showed that simulating positive hypothetical scenarios may temporarily release emotional tension associated to an upcoming stressful event (e.g., Brown et al., 2002). Besides, envisioning the process of working toward the achievement of a desired goal may aid goal-directed behaviour by triggering people to develop an organizational structure that can be used to fine tune the behaviour itself (see Taylor et al., 1998, for a review). For example, Taylor and colleagues (1998) showed that goal completion in academic contexts (e.g., to pass upcoming midterm examinations) improves if students are trained to mentally simulate the scenarios (e.g., to imagine where and how long they would study) in which a future goal could be completed. Future simulations can also increase the likelihood of carrying out future intentions. Studies of implementation intentions (Gollwitzer, 1993) have extensively documented that using if-then plans ("If situation Y arises, then I will initiate behaviour Z") helps people translate their intentions into actual behaviour (e.g., Gollwitzer & Sheeran, 2006). It is assumed that the effectiveness of implementation intentions relies on the creation of associations between the anticipated situation, which implies the selection of a likely future situation, and the relevant behaviour (e.g., Gollwitzer, 1993; Webb & Sheeran, 2007). The effectiveness of implementation intentions on goal achievement has been

⁴ Neroni, M. A., Gamboz, N., & Brandimonte, M. A. (2014). Does episodic future thinking improve prospective remembering?. *Consciousness and cognition*, 23, 53-62.

demonstrated in a variety of domains (e.g., interpersonal, environmental, and health; Gollwitzer & Sheeran, 2006).

On the other hand, future simulations do not always play an adaptive function (Schacter, 2012). For instance, people tend to underestimate the resources they will need to complete a future task and overestimate the ease with which they will complete the task (see Buehler, Griffin, & Peetz, 2010, for a review). This phenomenon is known as planning fallacy and may trigger poor planning outcomes. Also, on balance, people are generally poor at predicting how they will feel after future events (affective forecasting; Kushlev & Dunn, 2011) and this may negatively affect decision-making processes (e.g., Loewenstein, O'Donoghue, & Rabin, 2003).

Although the above-mentioned lines of research have developed in parallel, altogether they provide important tips on the benefits and harm of future simulations. The present study aimed at further empirically assessing the benefits that may arise from future simulation. Note that future simulation may take many forms, such as superficial thoughts, inner speech, vague images, or vivid and consuming scenarios (e.g., D'Argembeau et al., 2011). In the present study, the interest was narrowed on the episodic forms of future simulation, i.e. the mental simulation of specific future events, usually labeled as "episodic future thinking" (EFT; Atance & O'Neill, 2001). In the last decade, most research on EFT mainly focused on better understanding the cognitive and the neural processes involved in EFT. Converging evidence from cognitive (e.g., D'Argembeau & Demblon, 2012; Gamboz et al., 2010), neuropsychological (e.g., Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Gamboz et al., 2010; Hassabis et al., 2007; Klein et al., 2002; Race et al., 2011) and neuroimaging studies (e.g., Addis, Pan, Vu, Laiser, & Schacter, 2009; Okuda et al., 2003; Szpunar et al., 2007) indeed suggest that EFT and memory rely on common psychological and neural processes.

The present study investigated whether EFT may improve prospective remembering. The mechanisms and the characteristics of PM abilities have been widely explored in the last decade (Brandimonte et al., 2010; Brandimonte & Ferrante, 2008; Burgess, Quayle, & Frith, 2001; Cicogna, Nigro, Occhionero, & Esposito, 2005; Einstein, McDaniel, Marsh, & West, 2008; McDaniel & Einstein, 2007; Simons, Scholvinck,

Gilbert, Frith, & Burgess, 2006). It was hypothesized that EFT may serve as an encoding strategy able to enhance prospective remembering by linking the prospective action to the mental representation of a specific context that can later cue the action. An example illustrated by Atance and O'Neill (2001) seems useful to clarify the concept:

“...suppose I must remember to take my medicine immediately upon returning home from work today. I might therefore decide before I leave the house in the morning to place my medicine bottle on the kitchen counter close to where the glasses are kept. To ensure the effectiveness of this mnemonic, however, it is important that I ‘pre-experience’ the events I am likely to engage in when I get home. If I fail to do this accurately, I might overlook, for example, the fact that, because today is Tuesday, when I get home I will probably go immediately into the living room to watch a favorite television program, going into the kitchen only when it is over. Thus, in this case, a more effective mnemonic would be for me to put my medicine on the coffee table in the living room rather than on the kitchen counter” (p. 533).

Partial support to the hypothetical beneficial effect of EFT on prospective remembering comes from at least three lines of research. First, there is evidence that imagery encoding may produce benefits in prospective memory performance above that found in typical encoding conditions. More precisely, Brewer, Knight, Meeks & Marsh (2011) have shown that participants who imagined themselves performing an event-based prospective memory task (i.e., imagine seeing a c-animal, and then imagine performing the appropriate word-non word response followed by pressing the “/” key) detected significantly more event-based cues than participants who received standard instructions (but McDaniel., Howard, & Butler, 2008, for different results). The authors suggested that these results demonstrate that the association formed at encoding between event-based prospective memory cues and the context in which they will ultimately occur is of great importance for successful cue detection. Results of this study, however, prevent any ultimate theorizing on the beneficial effect that EFT may have on prospective memory; in fact, participants were asked to imagine performing a simple, discrete action that lacks all those phenomenal, spatial, temporal, and emotional details that characterize more complex autobiographical

events, such as those that characterize EFT. Furthermore, participants did not verbalize the content of the imagined scenario; it was therefore impossible to ensure that participants were actually envisioning the future rather than simply repeating the instructions.

Second, Leitz et al. (2009) and Paraskevaides et al. (2010) found that prompting participants to mentally simulate an intended action at the moment of encoding significantly improved PM performance as compared to control conditions. Both these studies used the Virtual Week (Rendell & Craik, 2000), a computerized task designed to tap prospective remembering in everyday life. During each virtual day, represented by a board around which to move, participants are required to make decisions about their day and remember to carry out specific tasks (e.g., buy paper when out shopping). Leitz et al. (2009) and Paraskevaides et al. (2010) suggested that future event simulation induced participant to associate the intention with a specific visual-spatial context that, in turn, when reactivated, acted as a cue that prompted task completion. However, their results can hardly unmask such a process. Indeed, participants in the future simulation condition were specifically instructed to set the simulated events in their own everyday life (e.g. to imagine the supermarket where they usually shopped). However, the visual-spatial (everyday life) context of the simulated events never occurred and could not therefore serve as a cue to prompt task completion, as suggested by authors. Indeed, participants simulated real life events but nevertheless moved around a virtual board. It is however relevant to note that future simulation produced a significantly greater improvement in event-based tasks, which rely on cues in the environment, as compared with time-based tasks, which depend on effortful monitoring.

Third, in the developmental arena, Nigro, Brandimonte, Cicogna and Cosenza (2013) recently investigated the relationship between retrospective memory, EFT and event-based prospective memory performance in preschool, first, and second grade children. Results showed that age and EFT abilities were significant predictors of prospective memory performance, independently of retrospective memory abilities.

To summarise, extant findings suggest interesting avenues for the investigation of the potential relationship between EFT and PM. However, as they stand, they are

inconclusive as to the causal role that EFT may play in aiding prospective remembering.

The purpose of the present study was, therefore, to further assess whether, and -if so- to what extent, constructing specific personal future scenarios aids prospective memory performance. In order to overcome what is, in my opinion, a controversial issue in Leitz et al.'s (2009) and in Paraskevaides et al.'s (2010) studies, in the present study participants simulated and experienced real events. To date, it was assessed the effects of episodic future thoughts that were, respectively, congruent and incongruent with the prospective memory task that would be actually performed at a later time. In the congruent condition, participants imagined to perform a PM task that was the same as the task they would be subsequently presented with; in the incongruent condition, participants imagined performing a task, consisting merely in an ongoing task that was different from the PM task they would be subsequently presented with. Control conditions, requiring participants to perform activities different from EFT unrelated to the upcoming task, were also included in order to ascertain the specific role of EFT in aiding PM performance. To the extent that EFT aids performance in PM tasks by linking an intention to the mental representation of a specific context that can later cue the intention, the following specific predictions can be formulated: (a) participants in the congruent condition should show better performance in the PM task than participants in the incongruent condition because the complete overlap between the encoding phase (the way in which an intention is formed) and the retrieval phase (the way in which an intention is retrieved and realized) should make the mental representation of the future situation highly activated and accessible, hence improving the realization of the delayed action; (b) participants in the incongruent condition should show worse performance in the PM task than participants in the control conditions because the incomplete degree of overlap between the simulated context at encoding and the retrieval context in which event-based cues will be encountered should interfere with the task to be performed, hence impairing PM performance.

6.2 The Present Study

The present Experiment consisted of two sessions occurring in two consecutive days. On the first session, on arrival, all participants were informed that they would be asked to perform a computer-based task on the successive day and received different instructions according to the specific experimental condition they were randomly assigned to. Half participants were informed that they would perform a Verb Decision Task (ongoing task condition), while the other half were informed that they would perform a prospective memory task (PM task condition) embedded in the Verb Decision Task. Next, all participants moved to a new location where they performed one of three interpolated tasks according to the experimental conditions. These interpolated tasks were as follows: (a) to imagine the sequence of events occurring on the following day starting from their arrival to the University until they would leave the laboratory after performing the task (EFT condition), (b) to draw a map of the laboratory and to tick the places where he/she stopped (map condition), and (c) to complete the Italian version of the State-Trait Anxiety Inventory (Lazzari & Pancheri, 1980; control condition). On the next day, half participants in the ongoing task condition performed the expected task (congruent condition) while the other half unexpectedly performed the prospective memory task (incongruent condition). All participants in the prospective memory task condition performed the expected task (congruent condition). The experimental conditions for the present Experiment are illustrated in Table 6.1.

Session I		Session II	Experimental Conditions
Expected Task	Interpolated Task	Performed Task	
Ongoing	EFT	Ongoing	Ongoing - EFT – Ongoing (Congruent)
		PM	Ongoing - EFT – PM (Incongruent)
	Map	Ongoing	Ongoing - Map – Ongoing (Congruent)
		PM	Ongoing - Map – PM (Incongruent)
	Control	Ongoing	Ongoing - Control – Ongoing (Congruent)
		PM	Ongoing - Control – PM (Incongruent)
PM	EFT	PM	PM - EFT – PM (Congruent)
	Map	PM	PM - Map – PM (Congruent)
	Control	PM	PM - Control – PM (Congruent)

Table 6.1. Summary of the experimental conditions used in the present Experiment.

With respect to the purposes of the present Experiment, the relevant comparisons are as follows. The comparison between the PM - EFT – PM (Congruent) condition and PM - Control – PM (Congruent) condition should provide important information on whether future-oriented thoughts, including the action to be performed later, improve the realization of the delayed action; if so, participants in the PM - EFT – PM (Congruent) are expected to show better performance in the PM task than participants in the PM - Control – PM (Congruent) condition. In the same vein, the comparison between the Ongoing - EFT – PM (Incongruent) condition and the Ongoing - Control – PM (Incongruent) condition should inform on whether future-oriented thoughts including an action different from the one that will be later performed impair the realization of the delayed action; if so, participants in the Ongoing - EFT – PM (Incongruent) condition are expected to show worse

performance in the PM task than participants in the Ongoing - Control – PM (Incongruent) condition. The comparison between the PM - EFT – PM (Congruent) condition and the PM - Map – PM (Congruent) condition should inform on whether the improvement of the realization of the delayed action derives specifically from future-oriented thoughts or whether it is also affected by imagery-related processes in themselves.

Further minor predictions can be formulated. For instance, the Ongoing - EFT – Ongoing (Congruent), Ongoing - Map – Ongoing (Congruent), and Ongoing - Control – Ongoing (Congruent) conditions should overall show faster response times than the PM - EFT – PM (Congruent), the PM - Map – PM (Congruent), and the PM - Control – PM (Congruent). This prediction derives from data reported in the prospective memory literature. Indeed, it has been shown that, while under some circumstances performance in the PM task requires limited attentional resources (e.g., Smith, 2003; Smith & Bayen, 2004; Smith, Hunt, McVay, & McConnell, 2007), under other circumstances it relies on an automatic retrieval of the action to be performed (Einstein, McDaniel, Manzi, Cochran, & Baker, 2000; McDaniel et al., 2004; Brandimonte et al., 2001). Based on these assumptions, in the present Experiment one can expect to find longer response times in the Verb Decision Task (the ongoing task) embedding the prospective memory task due to the specific characteristics of our prospective memory targets, which were non-distinctive, non-salient and non-focal (not highly associated with the prospective response). In these circumstances, some costs at the ongoing task are expected, due to the allocation of additional cognitive resources to complete the prospective memory task in competition with the ongoing task (McDaniel & Einstein, 2007).

6.3 Method

6.3.1 *Participants*

One hundred and eighty young adults from Suor Orsola Benincasa University were initially enrolled for participating in this Experiment. However, thirty of them did not come to the second session. More precisely, there were six missing participants in the Ongoing – EFT - Ongoing condition, two in the Ongoing -Map -PM condition, six in the Ongoing – Map - Ongoing condition, six in the Ongoing-Control-Ongoing condition, three in the PM – EFT - PM condition, two in the PM – Map - PM condition and five in the PM – Control - PM condition. The final sample therefore consisted of one hundred and fifty participants. Their average age and education were 21,58 (SD = 3,33) and 14,78 (SD = 0,46) years, respectively. No participant had a history of neurological or psychiatric disorders. Participants were pseudo-randomly assigned to the nine experimental conditions included in the present study.

6.3.2 *Materials and Procedure*

On the first session, all participants were first asked to sit in front of a computer screen and provided with the instructions concerning the Verb Decision Task. The task consisted in presenting 30 Italian verbs, each randomly presented four times, individually appearing in the middle of the computer screen. Participants had to decide whether or not a verb had double consonants by key press. Half of the verbs had double consonants while the other half did not. Other six verbs (half with double consonants and half without double consonants) were used as buffers at the beginning of the task. Therefore, the ongoing task comprised overall 126 trials (Appendix I). The task could be initiated by pressing any key. Each trial consisted of the following sequence of events. First, a fixation cross was presented for 5000 M_{sec}; then the verb was presented in the middle of the screen and remained in view until

the participant pressed the response key (the Q key when double consonants were present and the P key when double consonant were absent; key response was counterbalanced across participants) or until 5000 M_{sec} had elapsed. Participants were instructed to respond as quickly as possible while avoiding errors. Participants in the PM condition received the additional instruction to press the spacebar whenever the target items occurred during the Verb Decision Task. The target items, each randomly presented four times, were the Italian verbs “andare” (to go) and “battere” (to beat). All participants, after task instructions, were presented with a brief training phase in order to ascertain whether they understood how to perform the task. They were also informed that, on the next day, they should complete the Verb Decision Task without further instructions from the experimenter. They were also informed that the task instructions would be anyway presented on the computer screen before the beginning of the task and that they were invited to carefully read them. Subsequently, they were invited to move to another place and asked to perform different interpolated tasks according to the experimental condition they had been assigned to. Participants in the EFT condition were asked to close their eyes and to imagine and describe the sequence of events expected to occur on the following day, starting from their arrival to the University until they would leave the laboratory after performing the task. It was further explained that the future situation had to be imagined in as much detail as possible, by describing not just how they would have performed the Verb Decision Task, but any action, feeling, thought and circumstance which might be associated with the future context (e.g. I will arrive at 9 with a friend of mine, I will be worried/ happy, after the task I will have a coffee). Participants in the Map condition were asked to draw a schematic map of the laboratory and to evidence, by drawing an X, the places they had kept on from their arrival to the laboratory to the current stage of the Experiment. Finally, participants in the Control condition completed the Italian version (Lazzari & Pancheri, 1980) of the part of the State-Trait Anxiety Inventory (Spielberger et al., 1983) assessing state anxiety. At the end of the first session, before they left the laboratory, participants were reminded that, on the next day, they would complete the experimental task without further instructions from the experimenter and were invited to carefully read the task instructions presented on the computer screen before the beginning of the task.

On the next day, participants were tested individually in a session lasting about 15 minutes. On arrival, the participant was received in the laboratory and then left alone to perform the Verb Decision Task. Before starting with the task, all participants read again the instructions on the computer screen. Importantly, at this stage of the Experiment (see Table 6.1), half participants in the ongoing task condition performed the expected task (congruent condition) while the other half unexpectedly performed the prospective memory task (incongruent condition). All participants in the prospective memory task condition performed the expected task (congruent condition). At the end of the second session, a post-experimental interview was carried out in order to ascertain whether participants noticed any difference between the task instructions they had received on the first session and the task performed on the second session. Indeed, assessing the participants' awareness of the conformity or discrepancy between the expected and the executed task, in the Congruent and Incongruent conditions, respectively (see Table 6.1), is indispensable to measure the benefits and costs of congruent and incongruent future oriented thoughts on later prospective performance.

6.4 Statistical Analyses

First, mean response times in the Verb Decision Task (ongoing task) in the congruent conditions (see Table 6.1) were analysed by means of a 2 (Expected task: ongoing vs. prospective memory) X 3 (Interpolated task: EFT vs. Map vs. Control) analysis of variance (ANOVA) in order to assess whether the additional requirement to execute a delayed action results in a slowdown of the performance in the ongoing task (as measured by slower response times at the Verb Decision Task when the additional prospective action has to be performed). Then, mean accuracy rates in the prospective memory task embedded in the Verb Decision Task were analysed with a 2 (Congruency: congruent vs. incongruent) X 3 (Interpolated task: EFT vs. Map vs. Control) ANOVA in order to assess whether EFT aids performance in the PM tasks. The between-subjects variable labeled as “congruency” refers to the congruency between the expected task in the first session and the executed task in the second session (see Table 6.1). Post-hoc comparisons contrasted the relevant experimental conditions as indicated in the previous section. In order to correct for multiple comparisons, significance was set at $\alpha = .025$.

Four participants (one participant in the Ongoing – EFT - PM incongruent condition; two participants in the Ongoing – Map - EFT incongruent condition; one participant in the Ongoing - Control - PM incongruent condition) were excluded from the analyses as they reported, in the post-experimental interview, that they had not noticed any difference between the task instructions received on the first session and the task performed on the second session.

6.5 Results

6.5.1 Response Times in the Verb Decision Task

Mean response times in the Verb Decision Task (the ongoing task) are presented in Table 6.2, as a function of the interpolated task.

	Interpolated Task		
	Control	EFT	Map
Ongoing Task	741.27 (SE = 45.13)	764.56 (SE = 45.14)	818.46 (SE = 45.14)
PM Task	998.86 (SE = 43.60)	968.85 (SE = 40.96)	991.38 (SE = 39.81)

Table 6.2 Mean response times (Msec) in the verb decision task (the ongoing task) in the congruent conditions as a function of interpolated task.

Results showed only a significant main effect of task, $F(1, 86) = 35.74$, $p < 0001$, $\eta_p^2 = .29$, indicating that participants were overall slower at responding when a prospective action had to be performed ($M = 986.36$, $SE = 23.95$) as compared to when the Verb Decision Task was the only task to be performed ($M = 774.76$, $SE = 26.06$).

6.5.2 Accuracy in the Prospective Memory Task

Mean accuracy rates in the prospective memory task obtained by participants in the congruent and in the incongruent conditions are presented in Table 6.3, as a function of interpolated task.

	Congruent	Incongruent
EFT	77.65 (7.34)	38.71 (7.34)
Map	51.47 (7.13)	33.83 (7.13)
Control	74.72 (7.81)	40.58 (6.49)

Table 6.3. Mean accuracy rates (and standard errors) in the prospective memory task obtained by participants in the congruent and in the incongruent conditions, as a function of interpolated task.

Results showed a significant main effect of congruency, $F(1, 98) = 25.82$, $p < .0001$, $\eta_p^2 = .21$, indicating that participants in the congruent conditions ($M = 67.94$; $SE = 4.29$) were overall more accurate than participants in the incongruent conditions ($M = 37.70$; $SE = 4.12$). The interaction between congruency and interpolated task resulted marginally significant, $F(2, 98) = 2.62$, $p = .07$, $\eta_p^2 = .05$. In order to better describe this interaction, two separate one-way ANOVAs were conducted, respectively, for the congruent and the incongruent conditions, with the interpolated task as a between subjects variable.

With respect to the congruent conditions, results showed a significant main effect of interpolated task, $F(2, 47) = 4.48$, $p < .02$, $\eta_p^2 = .16$. Planned comparisons showed that the accuracy rate in the EFT condition ($M = 77.65$; $SE = 6.51$) was significantly higher than the accuracy rate in the Control condition ($M = 51.47$; $SE = 6.93$), $t(30) = 2.51$, $p < .02$; $\eta_p^2 = .17$, but that it was equivalent to the accuracy rate in the Map condition ($M = 74.72$; $SE = 6.32$), $t(33) = 0.41$. As regards the incongruent conditions, the effect of interpolated task was not significant, $F(2, 51) = 0$. The inspection of accuracy rates reported in Table 6.1 seems to suggest that the accuracy rate in the congruent condition, with the control interpolated task, approximates accuracy rates in all incongruent conditions. Planned comparisons confirmed this impression (PM-Control-PM vs. Ongoing-Control-PM, $t(32) = .88$; PM-Control-PM vs. Ongoing-EFT-PM, $t(30) = 1.05$; PM-Control-PM vs. Ongoing-Map-PM, $t(31) = 1.48$, all n.s.).

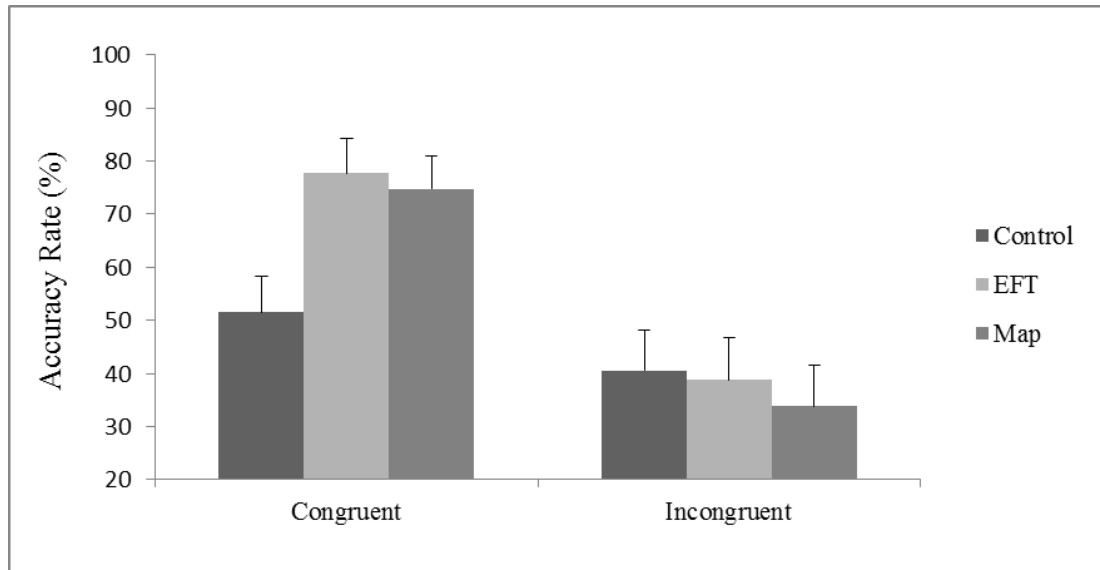


Figure 6.1. Mean accuracy rates (in percentage) in the prospective memory task obtained by participants in the congruent and in the incongruent conditions, as a function of interpolated task. Error bars indicate standard errors.

6.6 Discussion

The main purpose of the present study was to assess whether future-oriented thoughts including the PM task to be performed improve performance in the PM task. Furthermore, it was examined whether future-oriented thoughts including a task different from the PM task to be performed impair performance in the PM task; if EFT aids performance in PM tasks by linking an intention to the mental representation of a specific context that can later cue the intention (e.g., Atance & O'Neill, 2001; Brewer et al., 2011; Leitz et al., 2009; Neroni et al., 2014; Paraskevaides et al., 2010), the incongruence between the imagined task and the later performed PM task may be reasonably expected to hamper performance in PM task.

The results of the present study clearly showed that accuracy rates in the PM task, performed on the second day, were significantly higher when participants, on the first day, had mentally simulated the sequence of events expected to occur on the

second day, including the PM task, than when they performed a control task. Thus, an important facilitating effect of EFT on PM performance was found when the mentally simulated future task matched the actual executed task. Unexpectedly, a facilitating effect was also evident when participants drew the map of the laboratory as compared to when they performed a control, interpolated task. Interestingly, accuracy rates in the PM task, performed on the second day, were equivalent when participant mentally simulated the sequence of events expected to occur on the second day, including a task that differed from the PM task, and when they performed a control, interpolated task. Thus, the hampering effect expected to operate when the mentally simulated future task differed from the executed task did not occur. Furthermore, accuracy rates in the incongruent conditions were equivalent to accuracy rates in the congruent condition with the control, interpolated task.

Before reasoning on the aiding effect that EFT seems to have on prospective remembering, two counterintuitive results that emerged in the present Experiment should be accounted for: The finding that the accuracy rate in the congruent condition with the EFT interpolated task was equivalent to the accuracy rate in the congruent condition with the Map interpolated task, and the lack of a hampering effect in the incongruent condition with the EFT interpolated task.

With respect to the first result, remind that in the present experiment a condition was included in which the interpolated task consisted of drawing the map of the laboratory in order to assess whether the improvement of the realization of the delayed action derives specifically from future-oriented thoughts or whether it is also affected by imagination in itself. The present results showing that the EFT and the Map conditions lead to equivalent accuracy rates in the PM task may appear, at a first glance, quite surprising given that the requirement of drawing the map of the laboratory does not require prospection, but it rather evokes retrospective memory processes as participants have to reproduce episodic information. It is important to note that the Map condition shared a crucial element with the EFT condition, namely the spatial context (simulated in the EFT condition and retrieved in the Map condition). On the basis of this consideration, the finding of equivalent accuracy rates in the PM task after the EFT and after the Map condition may be accounted for

in at least two ways. First, it may be assumed that, when drawing the map of the laboratory, participants spontaneously relied on prospection. Second, knowing that the spatial context is a crucial element of EFT (e.g., Hassabis & Maguire 2007, 2009; de Vito et al., 2012) and knowing the important effect that the spatial context has on the realization of intentions (e.g., Gollwitzer & Sheeran, 2006), one may hypothesize that it was the deep processing of the spatial context that provided the contextual cue for the improved performance in the PM task the next day in the Map condition, so as to cancel the difference with the EFT condition.

To assess whether the spatial context indeed led to equivalent accuracy rates in the PM task in the EFT and the Map conditions, 10 additional new participants (age, $M = 22.50$, $SD = 4.14$; education, $M = 15.40$, $SD = 0.84$) were asked to perform the task under the congruent condition with the Map interpolated task, with the only difference that rather than drawing the map of the Lab they were required to draw the map of their neighborhood. Mean accuracy rate in the PM task for this new group of participants ($M = 62.30$; $SD = 22.98$) was indeed significantly lower than the accuracy rate of participants in the congruent condition with the EFT interpolated task, $t(25) = 2.06$, $p < .05$, $\eta_p^2 = .15$. This result reasonably indicates that the improvement in the realization of the delayed action derives specifically from future-oriented thoughts rather than from imagination in itself. Furthermore, this result suggests that the spatial context played indeed a crucial role in the Map condition; nevertheless, it does not provide a direct, empirical evidence that the spatial context cued prospective remembering in the Map condition. Generally speaking, future research should focus on ascertaining to what extent it is imagining performing the prospective actions, imagining where (spatial context) or imagining when (temporal context), that aids prospective remembering. This issue will be discussed later.

As regards the second question, i.e., the lack of a detrimental effect in the incongruent condition with the EFT interpolated task, it may be speculated that this effect did not occur because the task used in the congruent conditions and the task used in the incongruent conditions were not completely different. Indeed, the PM task consisted of the same Verb Decision Task used in the incongruent conditions, with the additional instruction to press the spacebar whenever the target items

occurred. Therefore, the mental representations created by participants in the incongruent condition with the EFT interpolated task may not have been sufficiently different from what they actually experienced on the second day, so as to interfere with their performance on the PM task. However this is an unlikely possibility because, if this was the case, a facilitating effect of EFT on PM task should have been observed even in the incongruent conditions (i.e., higher accuracy rates in the incongruent condition with the EFT interpolated task than in the incongruent condition with the control interpolated task). Might the lack of a detrimental effect in the incongruent condition with the EFT interpolated task be attributed to the participants' unfulfilled expectations? Indeed, participants in the incongruent conditions performed a task, on the second day, which did not correspond to what they expected to do. However, this hypothesis seems unlikely because, if this was the case, it should have been found overall lower accuracy rates in the incongruent conditions, in which participants performed a task that did not correspond to what they expected to do, as compared to the congruent conditions, in which participants performed the task they expected to do. In fact, the results of the present Experiment showed that rates in the incongruent conditions were equivalent to accuracy rates in the congruent condition with the control, interpolated task.

A final consideration is in order before reasoning on the aiding effect that EFT seems to have on PM. The present results showed that accuracy rates in the congruent condition with the EFT interpolated task were significantly larger than accuracy rates in the other four conditions included in the present Experiment (the congruent condition with the control interpolated task and the incongruent conditions). Before concluding that it is indeed EFT, i.e., envisioning performing the PM task, that aids performance in this condition, another possibility should be considered. The act of mentally imagining to perform the PM task may have simply improved the encoding in memory of the prospective action to be performed, thus increasing the accuracy rate in the congruent condition with the EFT interpolated task. If so, one could expect the congruent condition with the EFT interpolated task to be similar, in terms of accuracy rates, to a condition in which participants deeply encode the instructions concerning the PM task. To account for this possibility, twenty new young participants (age, $M = 22,05$, $SD = 3,11$; education, $M = 14, 20$, $SD = 0,20$)

performed the PM task in a single experimental session. They sat in front of the computer screen and were provided with the instructions concerning the PM task. Then, they were presented with a brief training phase in order to ascertain whether they had understood how to perform the task. They were further asked to repeat aloud the instructions and finally, before starting with the task, they read once again the task instructions on the computer screen. A post-experimental interview ascertained that all participants correctly understood the task instructions. Mean accuracy rate in the PM task for this new group of participants ($M = 47.50$; $SD = 8.65$) was indeed significantly lower than mean accuracy rate of participants in the congruent condition with the EFT interpolated task, $t(35) = -2.87$, $p < .01$, $\eta_p^2 = .20$. It can be, therefore, reasonably concluded that it is EFT that aids performance in PM task, over and above an appropriate encoding in memory of the prospective action to be performed. In future research, it is therefore important to assess whether future-oriented thoughts including a PM task -and not just a simple task, different from the PM task to be performed - impair performance. This issue will be discussed later.

Going back to the original question (i.e., does episodic future thinking improve prospective remembering?), the present results seem to provide convincing evidence that there is a basic level of performance in PM tasks on which EFT intervenes by improving the realization of the prospective action. Nevertheless, there is still much that needs to be elucidated. For instance, an important issue that needs to be clarified is the source of the aiding effect of EFT on PM performance. Is it sufficient to imagine carrying out the prospective actions, or is it also necessary to mentally simulate when and where the actions will occur to gain beneficial effects on PM? The present results currently do not allow us to fully answer this question. There is, therefore, a pressing need for future research to focus on ascertaining to what extent the beneficial effect of EFT on PM depends on imagining performing the prospective actions, on imagining where and when the prospective actions will be performed, or on the interaction between these elements. This may be achieved by assessing whether there is any detrimental effect on PM performance when participants simulate to perform a PM task different from the PM task they will later perform, when participants simulate to perform a PM task in a different context from the one

where they will later perform the PM task and when they simulate to perform the PM task at a different time from when they will actually perform it.

Another consideration is in order. In the present Experiment, in order to increase the uncertainty concerning the future, to-be-simulated event, there was a one-day interval between the first and the second session. This choice was motivated by the intention to prompt participants to holistically pre-experience the future event (e.g., to imagine not just to perform the task, but any action, feeling, thought and circumstance that might be associated with the future context). Furthermore, participants were presented with task instructions twice, on the first as well as on the second session. This was a necessary step as participants in the incongruent condition received, on the second day, different instructions as compared to those they had received the day before. Although this procedure differs markedly from the typical laboratory-based studies on PM, it can nonetheless be considered an example of ecologically valid experimental procedures, as it reflects everyday life situations of long-term PM. Indeed, PM paradigms usually adopt very short retention intervals between instructions and the presentation of a prospective memory target (from few minutes up to a maximum of 30 minutes) and participants are presented with instructions only once. However, in everyday life, it is seldom the case that people's future plans are to be realized in an immediate future. Future research should examine whether the aiding effect of EFT varies according to the time interval between the moment of the simulation and the moment of the execution of the prospective task, as well as to the number of times instructions are presented.

Finally, the results concerning the prospective memory task showed that participants were slower at responding in the ongoing task when they had to perform an additional prospective action as compared to when they performed only the ongoing task. Earlier studies in the prospective memory literature indicated that the retrieval and the execution of an intention are, under some circumstances, largely automatic (Einstein, et al., 2000; McDaniel, et al., 2004; Brandimonte et al., 2001), while, under other circumstances, they may require an appreciable commitment of cognitive resources (Smith, 2003; Smith & Bayen, 2004; Smith et al., 2007). Currently, the preponderance of evidence supports the multiprocess theory (McDaniel & Einstein,

2000), which combines aspects of the automatic and strategic views. For instance, consistent with this framework, some studies have shown that participants allocate more or fewer resources to prospective remembering as a function of the relative importance of the prospective memory task (Kliegel et al., 2001; 2004; Brandimonte et al., 2010), of the target distinctiveness and familiarity (Brandimonte & Passolunghi, 1994; McDaniel & Einstein, 1993; Utzl, 2005) and of the associativity of the target with the intended action (Einstein et al., 2005, McDaniel & Einstein, 2007). Therefore, the present results support the multiprocess view, by providing additional evidence that the automatic or strategic retrieval of an intention is not an “all-or-none” process (McDaniel & Einstein, 2007), but it strongly depends on the characteristics of the prospective memory task.

7 Mentally simulating when and where a delayed action will occur facilitates prospective remembering

7.1 Introduction

Extant findings suggest that EFT may improve the realization of the prospective action (Brewer et al., 2011; Leitz et al., 2009; Paraskevaides et al., 2010). Nevertheless, there is still much that needs to be elucidated. For instance, in Chapter 6, it was questioned the source of the beneficial effect of EFT on PM performance.

What characterizes EFT are the three “ w_s ”, i.e., imagining *what* will be done, imagining *when* it will be done, and imagining *where* the action will be done. Indeed, when individuals simulate personal future events, they imaginatively place themselves into specific settings that are temporal in nature (e.g., Tulving, 1985, 2002). Importantly, the simulated event is often flavoured with emotions of various valence and intensity. These emotional elements may be more or less numerous and vivid depending on several factors, first of all the temporal distance from the present. It is, therefore, reasonable to ask whether it is sufficient to imagine carrying out the prospective actions, or it is also necessary to mentally simulate when and where the actions will occur to gain beneficial effects on PM. Extant findings currently do not allow us to fully answer this question. Indeed, the *what*, *when* and *where* components of future thoughts were inseparable in the three studies investigating the role of EFT in prospective remembering. Thus, these studies do not allow to identify the specific contribution of each component.

It is important to mention a recent study by Brewer, Knight, Meeks and Marsh (2011), unrelated to the research on EFT, which confirmed the efficacy of simple imagery encoding in improving prospective memory performance. In that study, participants who imagined themselves performing the prospective action (i.e., imagine seeing a c-animal, and then imagine performing the appropriate word-non

word response followed by pressing the “/” key) detected significantly more event-based cues than participants who received standard instructions (but see McDaniel et al., 2008, for different results). The authors suggested that these results demonstrate that the association formed at encoding between event-based prospective memory cues and the context in which they will ultimately occur is of great importance for successful cue detection. In that study, participants imagined performing a simple discrete action and they likely created a mental representation mostly based on the *what* (performing the PM task), while the *when* and *where* were weakly represented. Generally speaking, the future scenario imagined by participants in Brewer et al.’s (2011) study lacked all those phenomenal, spatial, temporal, and emotional details that characterize more complex autobiographical events, such as those that characterize EFT.

The present study aimed at ascertaining to what extent the beneficial effect of EFT on prospective remembering depends on imagining *where* (Experiments 1A and 2A) and *when* (Experiments 1B and 2B) the prospective actions will be performed. All Experiments consisted of two sessions occurring in two consecutive days and had an equivalent structure (see Method). In order to evaluate the role of the temporal and of the spatial components of EFT in aiding prospective remembering, in all Experiments, it was created a mismatch between what participants imagined to do and what they actually did. Indeed, in the congruent conditions participants imagined to perform an event-based PM task at a specific time and in a specific place, which corresponded to the time and place in which they would actually perform the task later. These conditions were the same as the congruent condition in Chapter 6. In the incongruent conditions, participants imagined to perform an event-based PM task at a different time (next month) or in a different location (Room B) from the one where they would later perform it (next day and Room A; see Method for further details). A control condition requiring participants to perform an activity different from EFT, unrelated to the upcoming task, was also included.

Concerning the *where* component, it seems reasonable to extend Brewer et al.’s (2011) hypothesis by suggesting that imagining a specific visual–spatial context likely induces participant to associate the intention with the context that, in turn,

when reactivated, may provide many cues able to prompt task completion. If so, i.e., if the *where* component of prospection significantly contributes to increase prospective remembering, one may expect that participants in the EFT congruent conditions should show better performance in the PM task than participants in the EFT incongruent condition.

As far as the *when* component is concerned, to the extent it significantly contributes to increase prospective remembering, accuracy rates should be reasonably expected to be higher in the EFT congruent condition as compared to the EFT incongruent condition. However, at the present stage of research, it is difficult to make specific predictions on how envisioning the correct time at which a prospective action has to be performed may affect prospective remembering. In general, it is well known that the closer the imagined event, the more detailed the mental representation. Indeed, the Temporal Construal Theory (Liberman, Trope, & Stephan, 2007; Trope & Liberman, 2003) suggests that events distanced in time (as well as in other dimensions, i.e., social, spatial, and hypothetically) are represented in a schematic, abstract manner that emphasizes central and superordinate features (high-level construals), whereas proximal events are represented in a concrete, less schematic manner that includes incidental and subordinate features (low-level construals; Trope, Liberman, & Wakslak, 2007). Construal level has been shown to affect a wide range of psychological phenomena, such as prediction, evaluation, and behaviour (Liberman et al., 2007). More relevant for the purpose of the present study, it has been shown that low-level construals contain more details of an event, the unfolding of the event and its context (the places, objects and people involved, the sounds, smells and sights; e.g., Liberman & Trope, 1998). On the basis of these findings, it is possible to speculate that the closer the action that a person foresees, more numerous the contextual details contained in the mental representation. Such contextual details, in turn, when reactivated, may likely prompt task completion. Therefore, to the extent that the *when* component of prospection significantly contributes to increase prospective remembering (by affecting the content of the mental representation), one may expect that foreseeing near events will improve prospective remembering to a larger extent than foreseeing distant events, i.e., participants in the EFT congruent condition, who imagine to perform the task the next day, should be expected to show

better performance in the PM task than participants in the EFT incongruent condition, who imagine to perform the task in a month, but perform it the next day.

7.2 Experiments 1A and 1B

Experiments 1A and 1B aimed at assessing to what extent the beneficial effect of EFT on PM depends on imagining exactly when and where the prospective action will be performed. On the first session, on arrival, all participants in Experiments 1A and 1B were informed that they would be asked to perform a computer-based task in a subsequent phase of the Experiment. Half participants in Experiment 1A were told that they would perform the task on the next day (congruent condition), while the other half were told that they would perform the task in a month (incongruent condition). In the latter case, participants were anyway asked to return to the Laboratory the next day to perform another task without giving them information about the task. Importantly, on the second day, all participants performed the computer-based task. In Experiment 1B, on the first session, half participants were received in room A (Laboratory; congruent condition) while the other half were received in room B (incongruent condition); all participants were informed that, on the next day, they would perform the computer-based task in the room they were received in. Notably, on the second day, all participants performed the computer-based task in room A (Laboratory). Therefore, both Experiments 1A and 1B comprised two congruent and two incongruent conditions, as summarized in Table 7.1 and 7.2.

	Session I	Session II	Experimental Condition
Expected Task	Interpolated Task	Performed Task	
PM/ND	EFT	PM	PM/ND - EFT - PM/ND (Congruent)
	Control	PM	PM/ND - Control - PM/ND (Congruent)
PM/NM	EFT	PM	PM/ND - EFT - PM/NM (Incongruent)
	Control	PM	PM/ND - Control- PM/NM (Incongruent)

Note. PM /ND = Prospective Memory Task / Next Day; PM / NM = Prospective Memory Task / Next Month.

Table 7.1. Summary of the experimental conditions used in Experiments 1A and 2A.

	Session I	Session II	Experimental Condition
Expected Task	Interpolated Task	Performed Task	
PM/rA	EFT	PM/rA	PM/rA - EFT - PM/rA (Congruent)
	Control	PM/rA	PM/rA - Control - PM/rA (Congruent)
PM/rB	EFT	PM/rA	PM/rB - EFT - PM/rA (Incongruent)
	Control	PM/rA	PM/rB - Control- PM/rA (Incongruent)

Note. PM /rA = Prospective Memory Task in room A; PM / rB = Prospective Memory Task in room B.

Table 7.2. Summary of the Experimental Conditions used in Experiments 1B and 2B.

With respect to the purposes of Experiments 1A and 1B, the relevant planned comparisons were as follows. The comparison between the EFT and Control congruent conditions should provide important information on whether future-oriented thoughts, including the action to be performed later, improve the realization of the delayed action; if so, participants in the EFT conditions were expected to show better performance in the PM task than participants in the Control conditions (see

Chapter 6). The comparisons between the EFT congruent and the EFT incongruent conditions, as well as between the EFT incongruent and the Control incongruent conditions, should inform on how imagining to perform an action at a different time as compared with when it will actually be performed or in a different context from the one where it will later be performed affects the realization of the delayed action. If imagining when and where the action will be performed significantly contributes to prospective remembering, participants in the EFT congruent conditions are expected to show better performance in the PM task than participants in the EFT incongruent conditions. As regards accuracy rates in the EFT and Control incongruent conditions, two outcomes are plausible: accuracy rates may not vary across conditions or they may be higher in the EFT incongruent than in the Control incongruent. This second possibility seems more likely; indeed, it is likely to assume that simply imagining to perform the prospective action, despite the envisioned time and context do not correspond to those in which the task will be subsequently executed, provides participants in the EFT incongruent condition with an encoding advantage, as compared to participant in the Control condition, that may, in turn, facilitate prospective remembering.

7.2.1 Method

7.2.1.1 Participants

Sixty young adults participated in Experiment 1A. Their average age and education were 21.24 (SD = 2.75) and 14.7 (SD = 1.16) years, respectively. Other sixty young adults participated in Experiment 1B. Their average age and education were 20.73 (SD = 2.16) and 14.67 (SD = 0.83) years, respectively. All participants were students from Suor Orsola Benincasa University and took part in the Experiments as volunteers. No participant had a history of neurological or psychiatric disorders. Participants were randomly assigned to the four experimental conditions included in the Experiments.

7.2.1.2 Materials and Procedure

On the first session, on arrival, all participants in Experiments 1A and 1B were asked to seat in front of the computer screen and were given instructions concerning the computer-based task. This procedure was the same as the event-based prospective memory task used in Chapter 6. It consisted in a Verb Decision Task where 30 Italian verbs were randomly presented four times, individually appearing in the middle of the computer screen. Participants had to decide whether or not a verb had double consonants by key press. Half of the verbs had double consonants while the other half had not. Other six verbs (half with double consonants and half without double consonants) were used as buffers at the beginning of the task. Additionally, participants received the instruction to press the spacebar whenever the target items occurred during the Verb Decision Task. The target items, each randomly presented four times, were the Italian verbs “andare” (to go) and “battere” (to beat). Therefore, the Verb Decision Task comprised overall 134 trials. Detailed information on the characteristics of individual trials are described in detail in Chapter 6. The task could be initiated by pressing any key. All participants, after task instructions, were presented with a brief training phase in order to ascertain whether they understood how to perform the task. They were also informed that, on the following session, they should complete the Verb Decision Task without further instructions from the experimenter.

Subsequently, they were invited to move to another place and asked to perform different interpolated tasks according to the experimental condition they had been assigned to. Participants in the EFT condition were asked to close their eyes and to imagine and describe the sequence of events expected to occur on the following session, starting from their arrival to the University until they would leave the laboratory after performing the task. It was further explained that the future situation had to be imagined in as much detail as possible, by describing not just how they would have performed the event-based PM task, but any action, feeling, thought and circumstance which might be associated with the future context (e.g. I will arrive at 9 with a friend of mine, I will be worried/ happy, after the task I will have a coffee). Alternatively, participants in the Control condition completed the Italian version

(Lazzari & Pancheri, 1980) of the part of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) assessing state anxiety.

On the next day, participants of Experiment 1A were received in the Laboratory by the experimenter and, importantly, all participants performed the Verb Decision Task.

Concerning Experiment 1B, participants in the congruent conditions were received in room A (the Laboratory) and then performed the Verb Decision Task; in contrast, participants in the incongruent conditions were received in room B and then moved to room A (the Laboratory) where they performed the Verb Decision Task. Before starting with the task, all participants, in both Experiments 1A and 1B, read again the instructions on the computer screen.

At the end of the second session, a post-experimental interview was carried out in order to ascertain whether participants remembered the task instructions. The second session lasted about 15 minutes.

7.2.2 Statistical analyses

Mean accuracy rates in the event-based PM task embedded in the Verb Decision Task were analysed with a 2 (Congruency: congruent vs. incongruent) X 2 (Interpolated task: EFT vs. Control) ANOVA in order to assess to what extent mentally simulating *when* (Experiment 1A) and *where* (Experiment 1B) the prospective action would be performed improves prospective remembering. The between-subjects variable labelled as “congruency” refers to the congruency between the time when (in Experiment 1A) and the place where (in Experiment 1B) participants imagined to perform the task in the first session and the actual time and place in which they performed the task in the second session (see Table 7.1 and 7.2). When necessary, post hoc comparisons contrasted the relevant experimental conditions. In order to correct for multiple comparisons, significance was set at $\alpha = .025$.

7.2.3 Results

7.2.3.1 Experiment 1A

Mean accuracy rates in the event-based PM task obtained by participants in the congruent and in the incongruent conditions are presented in Table 7.3, as a function of interpolated task.

	Congruent	Incongruent
EFT	83.87 (3.58)	57.38 (3.34)
Control	59.8 (8.63)	72.1 (8.1)

Table 7.3. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 1A in the congruent and in the incongruent conditions, as a function of interpolated task.

Results showed a significant interaction between congruency and interpolated task, $F(1, 53) = 8.85$, $p < .005$, $\eta_p^2 = .14$. Post-hoc comparisons showed that accuracy rates in the EFT congruent condition ($M = 83.87$; $SE = 3.58$) were significantly higher than accuracy rates in the Control congruent condition ($M = 59.80$; $SE = 8.63$), $t(28) = 2.57$, $p < .01$, $\eta^2 = .21$, on the contrary, accuracy rates in the EFT incongruent condition ($M = 57.38$; $SE = 3.34$) were equivalent to accuracy rates in the Control incongruent condition ($M = 72.14$; $SE = 8.1$), $t(25) = 1.63$, $p = .11$. Furthermore, accuracy rates in the EFT congruent condition ($M = 83.87$; $SE = 3.58$) were significantly higher than accuracy rates in the EFT incongruent condition ($M = 57.38$; $SE = 3.34$), $t(26) = 5.35$, $p < .001$, $\eta^2 = .44$, while accuracy rates in the Control congruent condition ($M = 59.80$; $SE = 8.63$) were equivalent to accuracy rates in the control incongruent condition ($M = 72.10$; $SE = 8.10$), $t(27) = 1.04$, $p = .31$.

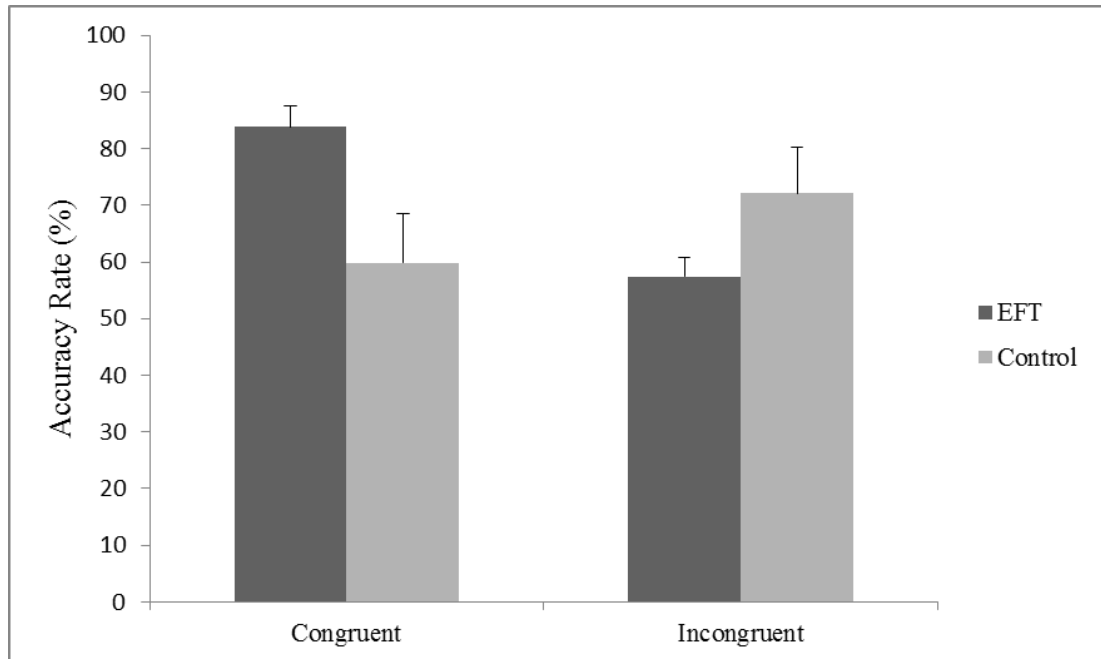


Figure 7.1. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 1A in the congruent and in the incongruent conditions, as a function of interpolated task.

7.2.3.2 Experiment 1B

Mean accuracy rates in the event-based PM task obtained by participants in the congruent and in the incongruent conditions are presented in Table 7.4, as a function of interpolated task.

	Congruent	Incongruent
EFT	80.83 (5.57)	82.5 (4.53)
Control	67.75 (7.41)	72.12 (6.19)

Table 7.4. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 1B in the congruent and in the incongruent conditions, as a function of interpolated task.

Results revealed a marginally significant effect of interpolated task indicating that, overall, participants who performed, on the first day, the EFT task showed higher accuracy rates ($M = 81.67$, $SE = 3.53$) than participants who performed the Control task ($M = 69.85$, $SE = 4.79$), $F(1, 53) = 3.86$, $p < .05$, $\eta_p^2 = .07$.

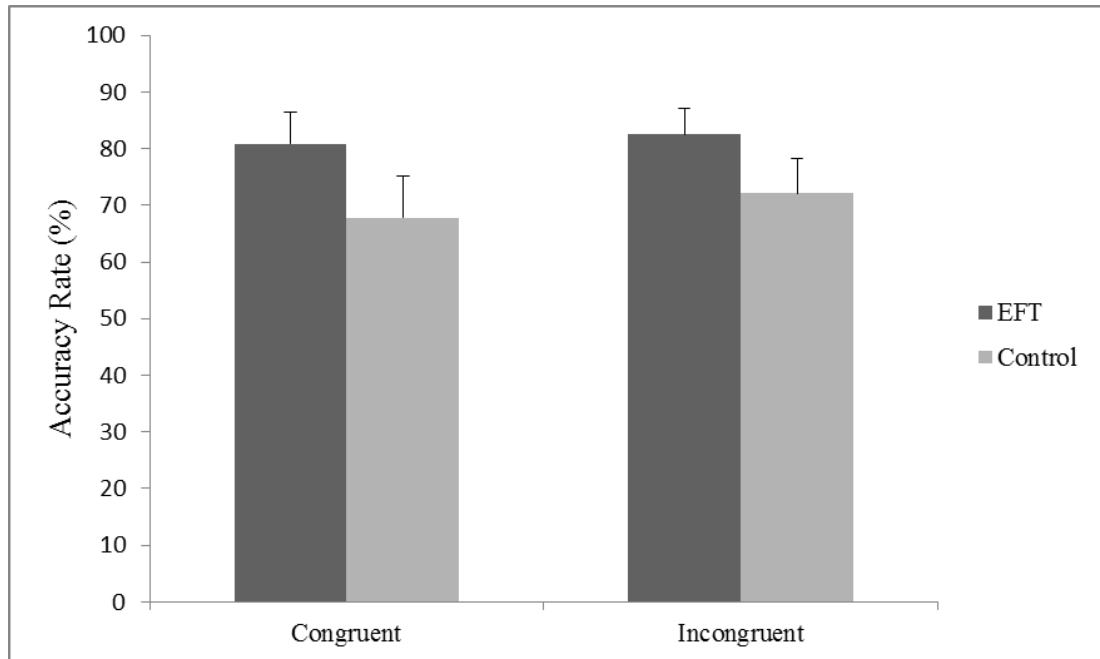


Figure 7.2. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 1B in the congruent and in the incongruent conditions, as a function of interpolated task.

7.2.4 Discussion

Results of Experiments 1A and 1B where, overall, in line with our earlier findings (Chapter 6) showing that EFT significantly increases the chances of promptly performing the prospective action when there is a complete overlap between what participants mentally simulate, on the first day, and what they actually do on the second day.

The results of the present Experiments further showed a differential effect of the temporal and of the contextual components of EFT on prospective remembering. More precisely, Experiment 1A revealed that mentally simulating to perform a task at a different time from when the task was actually performed did not enhance prospective remembering; indeed, accuracy rates in the EFT incongruent condition was equivalent to accuracy rates in the control conditions. This result clearly shows

that the temporal component of prospection contributes to enhance prospective remembering, over and above simply imagining to perform the prospective action (Brewer et al., 2011). It remains however unclear why participants in the EFT incongruent condition showed no benefit at all. Indeed, although participants in the EFT incongruent condition expected to do the PM task in a month, and likely foresaw a future context less rich in details as compared to participants in the EFT congruent condition (e.g., Trope & Liberman, 2003), they still encoded the prospective action to a larger extent as compared to participants in the control incongruent condition. It was therefore reasonable to expect a positive effect, in the EFT incongruent condition, on prospective remembering, although reduced as compared to the effect in the EFT congruent condition. It seems unlikely that the lack of any effect of the EFT incongruent condition on prospective remembering can be attributed to the fact that participants did not expect to perform the PM task the next day (expectancy effect). If this was the case, lower accuracy rates should be found in the incongruent control condition as compared to the congruent control condition. Rather, the present results showed that accuracy rates in these two conditions were equivalent.

Experiment 1B showed a beneficial effect of EFT on prospective remembering in both the EFT congruent and EFT incongruent conditions. This is an unexpected result that calls into question the hypothesis that the spatial component of EFT plays an important role in facilitating prospective remembering. Given that participants performed a computer-based task, perhaps, what really mattered was just imagining themselves performing the prospective action, as it was the case in Brewer et al.'s (2011) study. This hypothesis needs to be further investigated.

Participants who showed, in the two Experiments, a significant effect of EFT on prospective remembering were those who performed the PM task on the second day (i.e., in Experiment 1, participants in the EFT congruent condition; in Experiment 1B, participants in the EFT congruent and participants in the EFT incongruent condition). One may therefore ask whether EFT may have induced these participants to think more about the task (and therefore to better encode in memory the prospective action to be performed) as compared to participants who did not expect

to perform the task on the second day (i.e., participants in the EFT incongruent condition in Experiment 1A). If so, EFT may not aid prospective remembering by acting exclusively at the time of the encoding, but it might also act by inducing people to think more about the forthcoming prospective task during the retention interval.

To account for the controversial issues emerged in Experiment 1B, two new Experiments were conducted.

7.3 Experiments 2A and 2B

Experiments 2A and 2B were overall the same as Experiments 1A and 1B with only some exceptions.

First, in Experiments 2A and 2B, on the second day, participants were not allowed to read again the instructions on the computer screen before starting to perform the task. This change in the procedure intended to better assess the “genuine” effect that EFT may have on prospective remembering.

Second, in Experiments 2A and 2B an activity-based PM task was included. It consisted in switching the light off before leaving the room, after completion of the computer-based task. This task was included in order to assess whether EFT differently affects prospective remembering according to whether the PM task does or does not require to interact with the spatial context; it is indeed reasonable to expect that, as long as participants have to perform a computer-based task, perhaps, what really matters is imagining themselves performing the prospective action. However, when participants have to interact with the spatial context, imagining spatial details may be far more important in order to gain a beneficial effect of EFT on prospective remembering.

Third in Experiments 2A and 2B, at the end of the second session, participants were invited to complete a short debriefing questionnaire assessing how often they thought about the task to be performed on the second day and how much they remembered

task instructions. It is reasonable to assume that the larger the time spent to think about the task, the better the encoding in memory of the prospective action to be performed. Therefore, knowing how often participants thought about the task may help ascertain whether EFT exerts its effect by acting on this aspect of behaviour, over and above its effect at the time of first encoding of the prospective action.

Forth, in Experiments 2A and 2B, the participants' descriptions of future scenarios were digitally recorded to enable transcription and later scoring of the participants' responses. This allowed to more directly estimate the qualities of participants' descriptions of future scenarios in order to assess more directly the main hypothesis on which this study is based, that is the richer in details the mental representation of the future scenario, the better prospective remembering.

7.3.1 Method

7.3.1.1 Participants

Eighty young adults participated in Experiment 2A. Their average age and education were 20.52 (SD = 2.85) and 14.31 (SD = 1.1) years, respectively. Other eighty young adults participated in Experiment 2B. Their average age and education were 20.36 (SD = 2.93) and 14.34 (SD = 1.1) years, respectively. All participants were students from Suor Orsola Benincasa University and took part in the Experiments as volunteers. No participant had a history of neurological or psychiatric disorders. Participants were randomly assigned to the four experimental conditions included in the Experiments.

7.3.1.2 Materials and Procedure

The material of Experiments 2A and 2B was the same as in Experiments 1A and 1B. With respect to the procedure, as anticipated earlier, three changes were made. First, after receiving the event-based PM task instructions and performing a brief training

phase, participants were provided with additional instructions concerning an activity-based PM task consisting in switching the light off before leaving the room, after completing the computer-based task. To this end, participants were shown the localization of the light switch. Next, participants moved to a different location where they performed, as in Experiments 1A and 1B, one of the two interpolated tasks according to the experimental conditions. Second, on the second day, participants did not read again the instructions on the computer screen before starting to perform the task. Third, at the end of the second session, participants were invited to complete, using a 7-points scale, a short debriefing questionnaire assessing (1) how much they thought, overall, about the experiment (1 = never; 7 = very often), (2) how much they remembered the main instructions for the computer-based task (1 = I did not remember them at all; 7 = I did perfectly remember them), and (3) how much they remember the instructions concerning specific words appearing during the computer-based task (1 = I did not remember them at all; 7 = I did perfectly remember them). Participants were also asked to report all the instructions they remembered. The experimental conditions for the present Experiments are illustrated in Table 7.1 and 7.2.

The qualities of participants' descriptions of the future scenario were estimated using the standardized scoring procedure developed by Levine, Svoboda, Hay, Winocur, & Moscovitch (2002). More precisely, for each description produced by participants, the central event (the event discussed in most detail that occurred over a brief time-frame) was first identified. The central event was then segmented into details, i.e., unique occurrences, observations, or thoughts (that typically occur as grammatical clauses defined by a subject and predicate, such as "I dropped my sandwich"). Details were classified as internal or external, internal details being those that were specific to time and place, and considered to reflect episodic re- or pre-experiencing, and external details being those that pertained to extraneous information that was not uniquely specific to the main event being described and not anchored to the time and place. Internal details were divided into further subcategories: (a) event (happenings, people involved, actions, nature of the environment), (b) place (information about where the event occurred), (c) time (date, season, or time of day), (d) perceptual (sensory information) and (e) emotion/thought relating to the event. External details

were also subcategorized: (a) event (specific details from other incidents, from all of the above categories, external to the main event recalled or imagined), (b) semantic (general knowledge or facts, ongoing events, extended states of being), (c) repetition (unsolicited repetition of details), and (d) other (metacognitive statements, editorializing). An example of the scoring procedure can be found in Appendix B.

The transcriptions were segmented into internal and external details by a single trained rater, who was blind to the hypotheses of the study. It is relevant to note that this rater scored events in a manner that was highly reliable with the ratings provided by the experimenter. The inter-rater reliability (r) was .97 and .97 for internal and external details, respectively.

7.3.2 Statistical analyses

For both Experiments 2A and 2B four sets of analyses were carried out. As in previous experiments, the between-subjects variable labelled as “congruency” refers to the congruency between the time when (in Experiment 2A) and the place where (in Experiment 2B) participants imagined to perform the task in the first session and the actual time and place in which they performed the task in the second session (see Table 7.1 and 7.2).

First, mean accuracy rates in the event-based PM task embedded in the Verb Decision Task were analysed by means of a 2 (Congruency: congruent vs. incongruent) X 2 (Interpolated task: EFT vs. Control) ANOVA in order to assess to what extent mentally simulating *when* (Experiment 2A) and *where* (Experiment 2B) the prospective action will be performed improves prospective remembering (thus replicating and extending the results of Experiments 1A and 1B).

Second, the mean number of details produced by participants in the EFT conditions was analysed by means of a 2 (Congruency: congruent vs. incongruent) X 2 (Details: internal vs. external) mixed ANOVA in order to evaluate whether and to what extent the level of specificity of the imagined future scenario affects prospective

remembering. When necessary, post-hoc comparisons contrasted the relevant experimental conditions. In order to correct for multiple comparisons, significance was set at $\alpha = .025$.

Third, mean accuracy rates in the activity-based prospective memory task were analysed by means of Chi-Square tests in order to assess whether the spatial component of EFT differentially affects prospective remembering according to whether the PM task does or does not require the participant to interact with the spatial context.

Finally, in order to evaluate to what extent the beneficial effect of EFT on PM may be attributed to the fact that engaging in EFT may induce participants to think more about the forthcoming prospective task during the retention interval, group differences in the debriefing questionnaire were examined by means of separate 2 (Congruency: congruent vs. incongruent) X 2 (Interpolated task: EFT vs. Control) ANOVAs, carried out for each question. When necessary, post-hoc comparisons contrasted the relevant experimental conditions. In order to correct for multiple comparisons, significance was set at $\alpha = .025$.

7.3.3 Results

7.3.3.1 Experiment 2A

Accuracy in the event-based prospective memory task. Mean accuracy rates in the event-based PM task obtained by participants in the congruent and in the incongruent conditions are presented in Table 7.5, as a function of interpolated task.

	Congruent	Incongruent
EFT	75.62 (2.05)	60.53 (1.66)
Control	43.42 (6.62)	56.25 (7.64)

Figure 7.5. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 2A in the congruent and in the incongruent conditions, as a function of interpolated task.

Results showed a significant main effect of interpolated task, $F(1, 73) = 8.81$, $p < .005$, $\eta_p^2 = .11$, indicating that, overall, participants in the EFT conditions showed higher accuracy rates ($M = 68.27$, $SE = 3.73$) as compared to participants in the Control conditions ($M = 49.5$, $SE = 5.07$).

The interaction between congruency and interpolated task was also significant, $F(1, 73) = 5.17$, $p < .05$, $\eta_p^2 = .07$. Post-hoc comparisons revealed that accuracy rates in the EFT congruent condition ($M = 75.62$; $SE = 4.67$) were significantly higher than accuracy rates in the Control congruent condition ($M = 43.42$; $SE = 6.62$), $t(38) = 3.97$, $p < .0001$; $\eta^2 = .29$, accuracy rates in the EFT incongruent condition ($M = 60.52$; $SE = 5.43$) were equivalent to accuracy rates in the Control incongruent condition ($M = 56.25$; $SE = 7.65$), $t(35) = 0.46$, $p = .65$.

Furthermore, accuracy rates in the EFT congruent condition ($M = 75.62$; $SE = 4.67$) were significantly higher than accuracy rates in the EFT incongruent condition ($M = 60.52$; $SE = 5.43$), $t(37) = 2.20$, $\eta^2 = .12$, $p < .05$, while accuracy rates in the Control congruent condition ($M = 43.42$; $SE = 6.62$) were equivalent to accuracy rates in the Control incongruent condition ($M = 56.25$; $SE = 7.64$), $t(36) = 1.27$, $p = .21$.

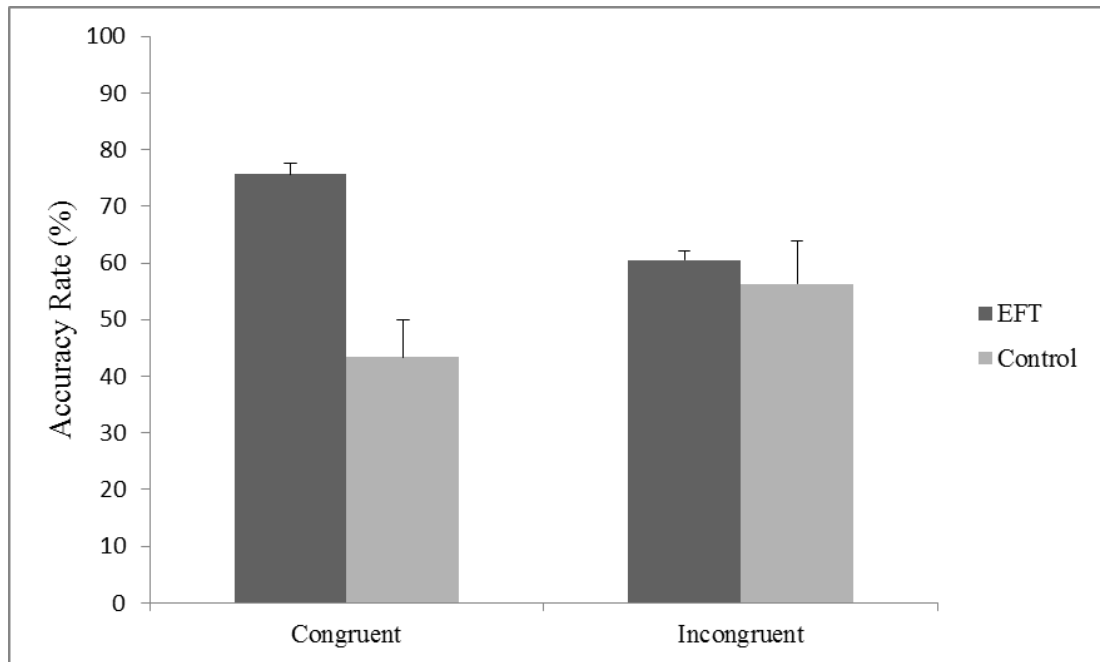


Figure 7.3. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 2A in the congruent and in the incongruent conditions, as a function of interpolated task.

Number of internal and external details. Mean number of internal and external details reported by participants in the EFT congruent and incongruent conditions are presented in Table 7.6.

	Congruent	Incongruent
Internal Details	15.5 (2.5)	10.53 (1.66)
External Details	2.5 (.56)	3.47 (.67)

Table 7.6. Mean number (and standard errors) of internal and external details obtained by participants in Experiment 2A in the EFT congruent and incongruent conditions.

Results showed significant main effects of congruency, $F(1, 37) = 3.90$, $p > .05$, $\eta_p^2 = .12$, and of details, $F(1, 37) = 67.54$, $p > .0001$, $\eta_p^2 = .64$, showing that, overall, participants produced significantly more details in the congruent ($M = 9.02$ SE =

0.90) than in the incongruent conditions, ($M = 6.47$, $SE = 0.92$), and that significantly more internal ($M = 12.58$, $SE = 1.14$) than external details ($M = 2.97$, $SE = 0.43$). The interaction between congruency and details was also significant, $F(1, 37) = 9.25$, $p > .005$, $\eta_p^2 = .20$. Post-hoc comparisons showed that participant produced significantly more internal detail in the congruent ($M = 15.55$, $SE = 2.0$) than in the incongruent condition ($M = 9.47$, $SE = 4.10$), $t(37) = 2.65$, $p < .02$, $\eta^2 = .14$, whereas the number of external details did not differ across conditions (congruent, $M = 2.50$, $SE = 0.56$; incongruent, $M = 3.47$, $SE = 0.67$), $t(37) = 1.11$, $p = .27$.

Accuracy in the activity-based prospective memory task. Accuracy rates in the activity-based prospective memory task obtained by participants in the congruent and in the incongruent conditions are presented in Table 7.7, as a function of interpolated task.

	Experiment 2A		Experiment 2B	
	EFT	Control	EFT	Control
Congruent	85	45	70	45
Incongruent	47.4	44.4	60	35

Table 7.7. Mean accuracy rates (in percentage) in the activity-based prospective memory task obtained by participants in Experiment 2A and 2B in the congruent and in the incongruent conditions, as a function of interpolated task.

Participants in the EFT congruent condition (85.0 %) showed higher accuracy rates than participants in the Control congruent condition (40.0 %), $\chi^2(1) = 8.64$, $p < .005$. In contrast, no difference was observed between accuracy rates in the EFT incongruent condition (47.4%) and in the Control incongruent condition (44.4%), $\chi^2(1) = .03$, $p = .86$. Additionally, participants in the EFT congruent condition showed higher accuracy rates than participants in the EFT incongruent condition, $\chi^2(1) = 6.21$, $p = .01$, while accuracy rates in the Control congruent condition were

equivalent to accuracy rates in the Control incongruent condition, $\chi^2(1) = .078$, $p = .78$.

Debriefing questionnaire. The mean ratings are presented in Table 7.8, as a function of interpolated task and congruency. As regards the first two questions (How much did you think, overall, about the experiment? How much did you remember the main instructions for the computer-based task?), results showed that the effects of congruency, $F_s(1, 73) < 1.45$, and of interpolated task, $F_s(1, 73) < 2.30$, were not significant, nor were the interactions between these two factors, $F_s(1, 73) < 2.0$. As regards the third question (How much did you remember the instructions concerning specific words appearing during the computer-based task?), results showed a significant effect of interpolated task, $F(1, 73) = 8.16$, $\eta_p^2 = .10$, $p < .01$, indicating that participants in the EFT condition reported they remembered better the prospective response and the conditions for making that response ($M = 4.54$, $SE = .19$) as compared to participants in the control condition ($M = 3.70$, $SE = .19$).

		Congruent		Incongruent	
		EFT	Control	EFT	Control
Experiment 2A	Question 1	3.2 (.19)	3.2 (.17)	3.2 (.14)	3.1 (.16)
	Question 2	4.3 (.24)	3.7 (.27)	4.3 (.23)	3.9 (.31)
	Question 3	4.6 (.21)	3.8 (.34)	4.5 (.21)	3.7 (.3)
Experiment 2B	Question 1	2.8 (.19)	2.8 (.19)	2.9 (.28)	2.9 (.23)
	Question 2	4.1. (.27)	3.3 (.27)	4.3 (.23)	4.1 (.29)
	Question 3	4.2 (.26)	3.7 (.2)	4.5 (.11)	3.6 (.24)

Note. Question 1 = How much did you think, overall, about the experiment?; Question 2 = How much did you remember the main instructions for the computer-based task?; Question 3 = How much did you remember the instructions concerning specific words appearing during the computer-based task?

Table 7.9. Mean ratings (and standard errors) of responses provided by participants in Experiments 2A and 2B to questions included in the debriefing questionnaire, as a function of congruency and of interpolated task.

7.3.3.2 Experiment 2B

Accuracy in the event-based prospective memory task. Mean accuracy rates in the event-based prospective memory task obtained by participants in the congruent and in the incongruent conditions are presented in Table 7.10, as a function of interpolated tasks.

	Congruent	Incongruent
EFT	66.25 (4.97)	66.85 (5.16)
Control	38.12 (2.3)	54.37 (1.32)

Table 7.10. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 2B in the congruent and in the incongruent conditions, as a function of interpolated task.

Results showed only a significant main effect of interpolated task, $F(1, 76) = 10.71$, $p < .005$, $\eta_p^2 = .12$, indicating that, overall, participants in the EFT conditions showed higher accuracy rates ($M = 66.55$, $SE = 3.54$) as compared to participants in the Control conditions ($M = 46.25$, $SE = 5.16$).

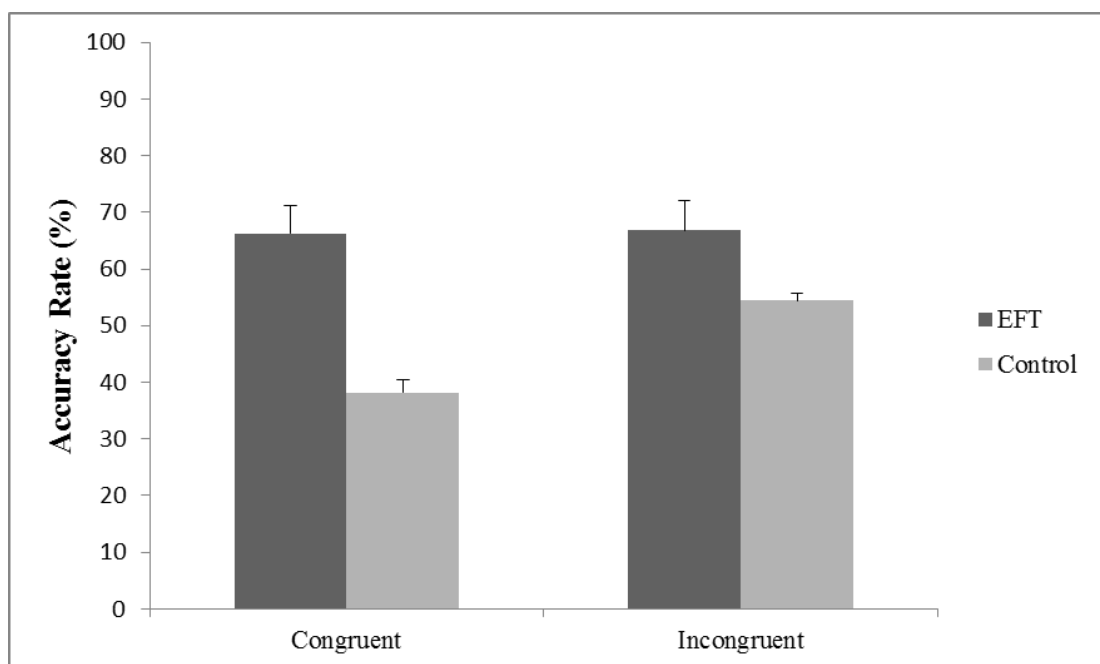


Figure 7.4. Mean accuracy rates (and standard errors) in the event-based prospective memory task obtained by participants in Experiment 2B in the congruent and in the incongruent conditions, as a function of interpolated task.

Number of internal and external details. Mean number of internal and external details reported by participants in the EFT congruent and incongruent conditions are presented in Figure 7.6. Results showed only a significant main effect of details, $F(1, 37) = 32.76$, $p < .0001$, $\eta_p^2 = .71$, showing that, overall, participants produced more internal ($M = 15.65$, $SE = 1.35$) than external details ($M = 1.87$, $SE = 0.33$).

	Congruent	Incongruent
Internal Details	17.7 (2.3)	13.6 (1.32)
External Details	1.6 (.45)	2.15 (.47)

Table 7.11. Mean number (and standard errors) of internal and external details produced by participants in Experiment 2B in the EFT congruent and incongruent conditions.

Accuracy in the activity-based prospective memory task. Accuracy rates in the activity-based prospective memory task obtained by participants in the congruent and in the incongruent conditions are presented in Table 7.7, as a function of interpolated tasks. Results mirrored those obtained in Experiment 2A. Participants in the EFT congruent condition (80.0 %) showed higher accuracy rates than participants in the Control congruent condition (45.0 %), $\chi^2(1) = 5.23$, $p < .05$. No difference was, however, found between accuracy rates in the EFT incongruent condition (50.0 %) and in the Control incongruent condition (35 %), $\chi^2(1) = .92$, $p = .34$. Additionally, participants in the EFT congruent condition (80 %) showed higher accuracy rates than participants in the EFT incongruent condition (50 %), $\chi^2(1) = 3.96$, $p = .05$, while accuracy rates in the Control congruent condition (45 %) were equivalent to accuracy rates in the Control incongruent condition (35 %), $\chi^2(1) = .42$, $p = .52$.

Debriefing questionnaire. The mean ratings are presented in Table 7.9, as a function of interpolated task and congruency. Results mirrored those obtained in Experiment 2A. Indeed, the effect of congruency, $F_s(1, 76) < 3.1$, of interpolated task, $F_s(1, 76) < 3.0$, and the interactions between these two factors, $F_s(1, 76) < 1.4$,

were not significant for the first two questions. As concerns the third question, the effect of interpolated task turned out to be significant, $F(1, 76) = 8.01$, $p < .01$, indicating that participants in the EFT condition reported better memory of the prospective response and the conditions for making that response ($M = 4.40$, $SE = .17$) as compared to participants in the control condition ($M = 3.70$, $SE = .16$).

7.3.4 Discussion

Results of Experiments 2A and 2B largely mirrored those obtained in Experiments 1A and 1B, respectively. Precisely, in both Experiments 2A and 2B, a significant beneficial effect of EFT was found on prospective remembering when there was a complete overlap between what participants mentally simulated on the first day and what they actually did on the second day. This aiding effect however vanished when there was a mismatch in Experiment 2A, as in Experiment 1A, between the imagined time at which participants expected to perform the PM task and the actual time at which they performed it. Conversely, EFT enhanced prospective remembering in Experiment 2B, as in Experiment 1B, even in the EFT incongruent condition, i.e., when participants imagined to perform the task in a room that was different from that one in which they actually performed the task on the next day, as compared to the control condition.

The methodological changes introduced in these new Experiments shed some light on the meaning of this pattern of results. First, the analysis of the characteristics of the future episodes described by participants in the EFT conditions in Experiment 2A showed that participants in the EFT congruent condition, who imagined to perform the PM task the next day, produced more internal details as compared to participants in the EFT incongruent condition, who imagined to perform the PM task the next month. These findings soundly support the proposed idea that the temporal component of prospection plays an important role in aiding prospecting remembering by affecting the content of the mental representations of future events: the closer the action that a person foresees, more numerous the contextual details contained in the mental representation (e.g., Trope & Liberman, 2003) that, in turn, when reactivated,

can serve as a cue to prompt task completion. To further strengthen this hypothesis, the correlation between accuracy rates and number of internal details turned out to be significant, ($r = .35$, $p < .03$). Importantly, the results obtained in the activity-based PM task mirrored those obtained in the event-based PM task. These results further support the idea that imagining the correct time at which a task has to be performed may significantly improve accuracy rates, at least when the prospective action has to be performed in the near future.

As regards Experiment 2B, the number of internal details produced by participants in the EFT congruent condition was equivalent to the number of internal details produced by participants in the EFT incongruent condition. This is indeed an expected result as participants in both conditions imagined to perform the PM task the next day. In addition, the rooms used in the congruent and incongruent conditions were the same as those used in Experiment 1B and, as already mentioned, they had, overall, very similar characteristics. This may have influenced previous results.

To date, the results obtained in the activity-based PM task seem to suggest that this is indeed the case: Participants in the EFT congruent condition showed higher accuracy rates as compared to both participants in the EFT incongruent and in the Control congruent condition. It is important to note that the light switch was located in two very different places in the two rooms, next to the computer and away from the exit door in room A, and away from the computer and close to the exit door in room B. Thus, in contrast with the event-based PM task, the mismatch between the characteristics of the imagined room (with respect to the light switch), and the characteristics of the room where participants actually performed the perspective task, eliminated the beneficial effect of EFT on prospective remembering. This pattern of results seems to suggest, in line with results of Experiments 1A and 2A, that the correspondence between the visuo-spatial details of future simulations and the real contexts significantly contributes to enhance prospective remembering, over and above simply imagining to perform the prospective action. It is however important in future research to ascertain whether EFT differentially affects event-based and activity-based (and, possibly, time-based) PM tasks.

Finally, it is interesting to note that there were no significant differences in the amount of time spent thinking about the task among conditions. This additional result clearly indicates that the effect of EFT on prospective remembering cannot be attributed to extra-experimental variables operating during the retention interval.

7.3.5 General Discussion

In Chapter 6, it was observed that accuracy rates in an event-based PM task were significantly higher when participants, the day before, had mentally simulated the sequence of events expected to occur on the next day, including the PM task, than when they performed a control task. The four Experiments discussed in this Chapter replicated this finding. Furthermore, Experiments 1A and 2A showed that envisioning the correct time at which the prospective action will be later performed is essential for detecting a beneficial effect of EFT on prospective remembering.

The analysis of the characteristics of future episodes seems to suggest, in line with the Temporal Construal Theory (e.g., Trope & Liberman, 2003), that the temporal component of prospection affects the content of the mental representations of future events. Indeed, participants who imagined performing the PM task next day (congruent condition) produced more internal details as compared to participants who imagined performing the task next month (incongruent condition). Furthermore, a significant correlation was found between accuracy rates in the PM task and number of internal details. One may speculate that there is a *causal* relationship between the richness of the context of envisioned future events and accuracy rates in the PM task. And, indeed, it does not seem to be any other discriminating factor (e.g., expectancy, post-experimental rehearsal of task instruction) between the congruent and the incongruent EFT conditions. How does the large number of contextual details enhance prospective remembering? It has been speculated that, when envisioning a future episode, a link is formed between the prospective action and specific contextual details that can later cue the action (Leitz et al., 2009; Neroni et al., 2014; Paraskevaides et al., 2010); accordingly, the richer in details the mental representation of the future scenario, the better prospective remembering.

This hypothesis is closely related to Experiments 1B and 2B where the spatial component of EFT was manipulated. In these two Experiments, both participants in the congruent and in the incongruent conditions imagined and performed the event-based PM task next day; accordingly, their mental representations of the future episode contained an equivalent amount of internal details. However, the mismatch between the imagined and the real spatial context did not hamper prospective remembering, as it could be expected if one assumes that a link is formed between the prospective action and specific contextual details that later cue the action. This unexpected result was likely due to fact that the two contexts (room A and B) had, overall, similar characteristics. The expected beneficial effect of EFT on prospective remembering was however significant in the activity-based PM task included in Experiment 2B, requiring participants to switch the light off before leaving the room; indeed, accuracy rates were significantly higher when the imagined and the actual room were the same as compared to when they were different. The crucial point is that the light switch was located in two very different places in the two rooms. Therefore, although results of Experiments 2A and 2B are less straightforward as compared to results of Experiments 1A and 2B, nonetheless they all converge in acknowledging the crucial role that the spatial component (the *where* component) of imagined future events has in aiding prospective remembering.

Although these initial findings suggest interesting avenues for the investigation of the potential relationship between EFT and PM, there is still much that needs to be elucidated. The present results provide a “snapshot” of a very circumscribed experimental situation. They were conducted by mainly using an event-based PM task with one-day delay between the moment when participants imagined performing the task and the time at which they actually performed it. Future studies should explore whether the beneficial effect of EFT on PM persists for longer periods of delay. In fact, although most PM laboratory studies require participants to retain deferred intentions for very short periods (i.e., Dismukes, 2010), in everyday life it is seldom the case that people’s future plans are to be realized in an immediate future. It is, therefore, reasonable to expect that the more distant is the time at which the intended action needs to be carried out, the more uncertain may be the conditions associated to its execution; this may ultimately lead to a less detailed future

simulation having little or no effect for supporting prospective remembering. Thus, examining the effect of EFT on PM using longer retention intervals between the moment when participants imagine performing the task and the time at which they actually perform it would help us to quantify the “temporal extension” of the aiding effect of EFT on PM.

Another important issue that needs to be clarified is whether EFT differently affects performance in different PM tasks. According to the type of target cue that signals the retrieval of the intended action, researchers typically distinguish among three main types of prospective memory tasks: those that are event-based (i.e., performing an action when a specific target event occurs in the environment, as the task used in our Experiments), those that are time-based (i.e., carrying out an action at a certain time or after a certain amount of time has elapsed), and those that are activity-based (i.e., performing an intended action after the completion of another activity, as the additional task included in Experiment 2B). It is well known that these different forms of PM task require different levels of self-initiated processing (and, perhaps, different amount of attentional demands; e.g., Henry, MacLeod, Phillips, Crawford, 2004; Brewer, Marsh, Clark-Foos, Meeks, Cook, & Hicks, 2011). Specifically, time-based PM tasks are considered to be more effortful than event-based PM tasks because, not supplying external able to guide remembering, they rely on internal control mechanisms (i.e., time estimation, Cicogna et al., 2005) and self-initiation (Einstein & McDaniel, 1990) to a greater extent as compared to event-based PM tasks. On the other hand, activity-based PM tasks are thought to be easier than either time-based and event-based PM tasks because they do not require the interruption of an ongoing activity to complete the intended action; accordingly, people should not shift their attention from the ongoing task in order to perform the PM task (Shum, Valentine, Cutmore, 1999). To the extent EFT aids PM performance by linking an intention to the mental representation of a specific context that can later cue the intention (e.g., Atance & O’Neill, 2001; Brewer et al., 2011; Leitz et al., 2009; Neroni et al., 2014; Paraskevaides et al., 2010), one may reasonably expect that EFT should be particularly useful in aiding prospective remembering when the PM task requires high level of self-initiation processing. This possibility has not been addressed so far.

A final interesting avenue for future studies may be to explore whether the benefits arising from episodic future simulation on prospective remembering also extends to more naturalistic settings and to more ecological PM tasks. In the present Experiments participants imagined a well-defined setting (i.e., the Laboratory) and to a very specific PM task (i.e., pressing the key bar when the PM target was encountered during the Verbal Decision Task; switching off the light of the Laboratory after completing the computer-based task). By contrast, in everyday situations the conditions underpinning the realization of an intended action are usually less defined and, thus, cannot be “pre-experienced” with a similar level of certainty. For instance, in everyday life, the PM target is usually defined by an “event” (i.e., arriving at the office, meeting a friend) that is characterized by multiple elements rather than by a single, discrete PM target providing a unique opportunity to execute the prospective action (Dismukes, 2010). Also, people may not always know what task they will be performing and how they will feel when the opportunity to execute the deferred intention arises (Dismukes, 2010). Therefore, in everyday life, people likely rely on a variegated range of episodic information to envision a future event, which can be adaptively used in the service of prospective remembering. Our understanding of the functional role of EFT in prospective remembering may benefit indeed from using new experimental paradigms able to create a bridge between real-world situations and existing laboratory paradigms. To this aim, a fruitful opportunity may be offered by the adoption of virtual reality tasks, which may allow researchers to investigate the interplay between EFT and PM within the laboratory context, but using settings and tasks which are closer to those experienced by people in their daily life.

To conclude, the results of the present set of Experiments are, overall, appealing because they strengthen the emerging view that sees EFT as a functional process able to provide humans with an essential selective advantage (e.g., Suddendorf & Corballis, 2007). Research has, indeed, shown that EFT represents a frequently occurring mental phenomenon that supports a range of adaptive behaviours, from planning to decision making, to self-control and the construction of a sense of identity (Atance & O’Neill, 2001; Boyer, 2008; Damasio, 1999; Schacter et al., 2008; Szpunar, 2010). In particular, it has been recently proposed that one of the

primary functions of mentally simulating specific future events (and, in particular, near-future events) is to implement mental simulations of action plans leading to goal attainment (D'Argembeau et al., 2011). It would be interesting, in future research, to ascertain to what extent people spontaneously engage in EFT in order to better encode delayed intentions, and whether EFT may serve as a cognitive strategy able to aid PM deficits.

8 Final Discussion

8.1 Summary of the main results

Over the past decade, the concept of prospection — the ability to represent what might happen in the future — has been the subject of rapidly growing research interest within various sub-disciplines of psychology and neuroscience (e.g., Szpunar, 2010, Szpunar et al., 2014). The capability to envision possible future events is pervasive in daily life and serves the basis for many cognitive processes, including decision making, planning, emotion regulation and problem solving (e.g., D'Argembeau et al., 2011). By previewing the future, people can indeed mentally “test” alternative hypothetical scenarios of what might happen, imagine how selecting different actions would play out, and mentally explore different courses of actions that could be taken to attain or avoid the imagined state of affairs.

To date, the study of prospection has been characterized by two main approaches. On the one hand, research has focused on investigating the cognitive underpinnings of this ability. Specifically, converging evidence from neuro-imaging, neuropsychological, cognitive, comparative and developmental studies have highlighted the contribution of episodic memory to prospection leading to the proposal that future simulation depends upon the ability to extract relevant information from memories of similar past experiences and the flexible recombination of these elements into a novel future event (Hassabis & Maguire 2011; Schacter et al., 2012).

On the other hand, attention has been directed towards investigating the functional benefits of engaging in prospection in everyday life. Within this context, a number of studies seem to suggest that prospection may significantly contribute to the successful pursuit and maintenance of psychological and functional wellbeing. For instance, imagining future contingencies associated to one's possible future state may help people develop better plans leading to future goals' achievement (Tyalor, et al., 1998), to better identify strategies to deal with possible future problems (Sheldon et

al., 2011) and to release emotional tension associated to an upcoming stressful event (e.g., Brown et al., 2002).

Following these two approaches, the present thesis aimed at further elucidating the cognitive and functional properties of human prospection.

The First Part of this dissertation revolved around the multifaceted nature of human prospection that, far from being considered as a monolithic entity, can be fractionated into variety of future experiences whose representational format is strongly influenced by the source of information that is used to furnish the future simulation. In particular, the two studies discussed in the First Part of this thesis investigated the role of different factors, such as the method used to elicit prospection and the valence of future events, in shaping various types of future events having a different representational formats and serving a range of functions.

In particular, Chapter 2 explored the effect of different verbal cues in influencing the characteristics of prospection by systematically comparing future events prompted through the commonly used cueing technique (i.e., experimenter-provided cues, Szpunar, 2010) and elicited by means verbal cues that were spontaneously generated by participants (i.e., self-generated cues), in terms of their quality, phenomenal characteristics, content and temporal distribution. The results showed that future events elicited by means of self-generated and by experimenter-provided cues did not differ with respect to their phenomenal characteristics. However, future events prompted by means of self-generated cues contained less episodic (i.e., specific) details than future events generated in response to experimenter-provided cues. Furthermore, the majority of future events imagined by participants in this study, regardless of the type of cue used to elicit prospection, were expected to occur in the very distant future and referred to culturally shared life-scripts. From this perspective, the results of this study complemented previous investigations pointing towards the role of other representational structures (different from episodic memory) in future simulation (e.g, D'Argembeau & Demblon., 2012) and revealed that future events commonly experienced by people in their daily life are not necessarily episodic in nature.

Chapter 3 investigated the effect of the emotional underpinnings of prospection in shaping different forms of future projection. Specifically, in this study, desirable and undesirable future events were systematically compared in terms of their quality, phenomenal characteristics, accessibility and content. The results showed that desirable future events were more detailed, more accessible, and more contextually and spatially specifically represented than undesirable future events. Besides, participants were more likely to indicate autobiographical memories as the source of their undesirable events, whereas they equally related the simulations of desirable events to autobiographical events and semantic knowledge. These findings provided an empirical support to the hypothesis that different types of memory and visual imagery processes underlie the simulation of best-case and worst-case scenarios (Atance & O'Neill, 2001).

Overall, the results of the studies discussed in the First Part of this dissertation support the claim that prospection is a complex process comprising a variety of future experiences, which may be differently constructed. Furthermore, they highlight the role of other representational structures, such as general autobiographical knowledge and semantic life-scripts, in mentally representing possible future contingencies.

The Second Part of this thesis intended to elucidate the role of scene and narrative construction processes in future simulation by specifically assessing whether and to what extent variances in the performance in the traditional tasks used to study prospection reflect difficulties/deficits in scene and narrative construction processes.

In particular, Chapter 4 investigated whether previously observed age-related difficulties in constructing imagined future events (e.g., Addis et al., 2008) may be accounted for by difficulties in scene and narrative construction. To this end, younger and older adults were instructed to either envision various types of imagined scenarios or to literally describe pictures of varying levels of complexity. The results confirmed previous observations (e.g., Gaesser et al., 2011) that ageing similarly affects the description of imaginative, future and current experiences. Furthermore, they showed that the age-related difficulties in narrative construction were exacerbated by the complexity of the construction, possibly reflecting an increasing

difficulty (due to an age-related LTM decline) in retaining and integrating a greater number of elements during the description process.

To obtain stronger evidence on the role of LTM-mediated processes in scene and narrative construction processes, in Chapter 5 the same tasks used in Chapter 4 were adopted to assess scene and narrative construction abilities in a group of amnesic patients, hence presenting medically-documented LTM deficits. The results of this study showed that amnesic patients were impaired at constructing detailed narratives about imaginary, future and current scenes. Besides, in line with the previous ageing study, it was observed that these deficits were exacerbated by the increased complexity of the scene to be described.

Overall, the results of the studies described in the Second Part of this thesis provide an important and empirical source of support to the hypothesis that difficulties and/or deficits in the performance in the experimental paradigms traditionally used to study prospection reflect, at least in part, impairments in LTM-mediated processes supporting scene and narrative construction.

The Third Part of this dissertation aimed at shedding additional light on the functional relevance of prospection in everyday life by investigating whether and in which circumstances future events simulation may improve the recollection and execution of a delayed action (i.e., prospective memory).

Specifically, Chapter 6 assessed the effect of episodic future events that were, respectively, congruent and incongruent with a prospective memory task to be performed at a later time. To this aim, it was created a mismatch between the task that participants simulated to execute and the task they actually performed. The results revealed that EFT significantly increased the chances of promptly performing the prospective action when there was a complete overlap between the simulated task and the actually executed task. However, when the envisioned task did not completely match the actual executed task, the facilitating effect of EFT on PM vanished. These findings seem, therefore, to suggest that the higher the degree of overlap between the simulated context at encoding and the retrieval context in which PM is executed, the greater the beneficial effect of EFT on prospective remembering.

Chapter 7 investigated whether and, if so, to what extent the observed beneficial effect of EFT on PM (Chapter 6) depended on specifically simulating the time and the context in which the future action would be performed. To this end, it was created a mismatch between *when* and *where* participants imagined to perform the PM task and *when* and *where* they actually executed it. With regards to the temporal component of EFT, the results showed that while imagining to perform a PM task at the time it was actually executed (i.e., the following day) facilitated PM performance, mentally simulating to perform a task at a different time from when the task was actually performed (i.e., the following month) did not enhance prospective remembering. As regards the spatial component of EFT, it was observed that the greater the correspondence between the visuo-spatial details of future simulation and the real context in which the PM task was actually executed, the stronger the beneficial effect of EFT on prospective remembering.

Overall, the results of the studies discussed in the last part of this thesis provided an empirical support to the hypothesis that simulating possible future contingencies associated to one's future improves the recollection and execution of an intended action, thus extending the functional relevance of prospection in everyday life. Furthermore, they revealed that this facilitating effect is greater when the simulated future scenario approximates the real context in which the future action is actually executed.

8.2 New insights into the cognitive properties of prospection

What arises from the studies discussed in this thesis is that there is not a single, uniform capacity for prospection but there are different ways of imagining the future, underwritten by distinct mechanisms. Thus, an exclusive focus on episodic form of prospection as well as on episodic contribution to future simulation (which have characterised the study of prospection for most of the past decade, for a review see Szpunar, 2010) are bound to lead to an incomplete understanding of prospection. At

odds with what Szpunar (2010) maintained, just as episodic memories represent particular instances of the personal past, the episodic form of prospection (i.e., episodic future thinking) reflects a particular way of projecting oneself forward in time. There are, indeed, innumerable ways to think about the future reflecting the contribution of different representational structures (e.g., D'Argembeau & Mathy, 2011; D'Argembeau & Demblon, 2012). Consistent with these assumptions, the First Part of this thesis revealed that episodic memory, general autobiographical knowledge and semantic schemata are flexibly recruited to different degrees to produce prospective thoughts that best suit current situational demands.

One of the factors which seems to strongly affect the source of information that is used to furnish the future simulation and, consequently, the representational format of the future event, is the level of accessibility of the information relevant for the simulation of interest. It was suggested that the content of prospection reflects the information that comes to mind most easily (Kahneman & Tversky, 1982; Szpunar, 2010; Tversky & Kahneman, 1973). Given that abstract (semantic) representations that are relevant to a given situation are generally more accessible than episodic representations of similar information (e.g., D'Argembeau & Demblon, 2012), it is likely that prospection more frequently results in general representations of the personal future (e.g., abstract knowledge about personal goals and anticipated events) rather than in temporally and contextually specific episodes. This hypothesis found an important source of support in recent studies showing that people frequently think about their personal future in abstract ways (Anderson & Dewhurst, 2009; D'Argembeau et al., 2011) and often access abstract knowledge about their future first when they attempt to imagine specific situations that might possibly happen to them (D'Argembeau & Mathy, 2011). In line with these observations, the results of the studies discussed in Chapters 2 and 3 revealed that self-generated future events (more spontaneously produced by participants) and positive future events (more accessible and rated as more often imagined by participants in their daily life) were more likely to reflect the content of general autobiographical knowledge and semantic life-scripts compared to their experimentally-induced and negative counterparts.

These observations seem to be in line with the more recent theorization on human prospection (i.e., “semantic scaffolding hypothesis”, Greenberg & Verfaellie, 2010; Irish et al., 2012; see also Szpunar et al., 2014) and additionally support the contribution of semantic memory to future simulation. Indeed, despite initial belief that semantic memory lacked a self-referential component, it now is well known that semantic memory stores information about one’s self (Klein, 2013). Self-referential semantic memory includes, but is not limited to, facts about one’s life (e.g., name, occupation, favourite foods), personal goals, personal attitudes, a sense of personal diachronicity and knowledge of one’s personality (Klein, 2013). Consequently, episodic impairment, even cases sufficiently severe to cover a person’s entire life, does not render the person necessarily incapable of imagining or anticipating his or her future (e.g., Kwan et al., 2012). To this regards, it is worth noticing that previous observations of preserved prospection in amnesia occurred when patients were free to imagine future scenarios of their choice or in cases of developmental amnesia in which hippocampal damage occurred perinatally or in early childhood (Maguire et al., 2010; Squire et al., 2010; Cooper et al., 2011). Under such conditions, it may be possible that patients could build simulations of the future by drawing on preserved generalized memory for routine events or well-established scripts in semantic memory (e.g., Maguire et al., 2010; Addis & Schacter, 2011; Maguire & Hassabis, 2011). And, indeed, some evidence reveals that a loss or a reduction of episodic memory can be easily compensated with an increased reliance on semantic information both when remembering (Levine et al., 2002) and when imagining (Gamboz et al., 2010).

Nevertheless, although relying on semantic knowledge to aid prospection may be an efficient compensation strategy when faced with episodic memory impairments, this information seem to be not sufficient in tasks requiring the construction of detailed future representations. An important source of support for this hypothesis comes from a study of Race and colleagues (2013) showing that, despite being able to list general issues relevant to future, when probed to elaborate on these issues patients with episodic amnesia produced impoverished descriptions (i.e., containing fewer details) than those of healthy controls. Critically, this impairment in producing detailed future representations occurred despite the semantic nature of the details

provided. This and similar observations (e.g., Rosenbaum et al., 2009) have recently led some investigators to propose that a critical factor determining the status of prospection and the LTM memory contribution to prospection is the level of detail required by the task (Race et al., 2013; Zeman et al., 2013). In particular, given that previous prospection impairments in both elderly people and in patients with amnesia were observed in tasks emphasising the description of detailed narratives (Romero & Moscovitch, 2012), it may be possible that these difficulties and/or deficits reflect an impairment in high-order processes supporting scene and narrative construction, over and above an impaired capability to anticipate future prospects.

The Second Part of this dissertation provides an important source of support to this hypothesis by showing that older adults' difficulties and amnesic patients' deficits in prospection also extend to tasks requiring the description of visually presented pictures. These results temper previous interpretations of the size of episodic memory decline in older adults and amnesic patients and emphasise the role of other cognitive processes (i.e., the capacity to construct a rich scene/narrative) in mediating these difficulties. Furthermore, the observation that these impairments were particularly conspicuous when to-be-described scenes were complex (thus requiring a greater amount of details to be maintained and integrated) rather than simple, suggest that the level of details required by the task can determine whether or not a (substantial) prospection deficit is observed in people with a decline or deficit in episodic memory. In other words, it can be hypothesised that whereas the simulation of simple or, possibly, even generalised scenes can be constructed via non-episodic memory processes, the construction of more complex and detailed future scenarios depends upon intact functioning of some aspects of episodic LTM, such as the episodic buffer, capable of online retention and integration of various information during the description process.

Overall, these evidence downside the role of episodic memory in prospection and suggest that different types of memory cooperate with one another and with other cognitive domains to aid forecasting.

8.3 New insights into the functional relevance of human prospection

The Third Part of this dissertation adds to the growing literature concerning the functional relevance of prospection by revealing the existence of an interplay between prospection and prospective memory (PM). Specifically, the results of the set of studies discussed in Chapters 6 and 7 showed that simulating the possible future contingencies associated to one's future action increases the recollection and execution of an intended action, thus providing an empirical source of support to the hypothesis that "future thinking might be particularly relevant to how we initially choose, or develop, the mnemonic that will allow us to remember our intended action in the future" (Atance & O'Neil, 2001, p. 533). Furthermore, more importantly, they suggest that the way in which a future scenario is simulated may modulate the effect of prospection on PM: The more the imagined scenario approximates the real context in which the PM task is actually executed (in terms of *what* may happen and *where* and *when* it may happen), the greater the beneficial effect of prospection on prospective remembering.

Nevertheless, it is worth noticing that the Third Part of this thesis focused on just one particular form of prospection referring to the simulation of temporally and contextually specific future events (EFT). However, in their everyday life, people not necessarily form intentions by imagining the specific temporal and contextual context associated to the realisation of the delayed action (Szpunar & Tulving, 2011). As they can create either specific or generic representations of future events that may occur in the future (Chapters 1 and 2), they can also form an intention in either a specific and general manner.

Although it cannot be concluded, on the basis of the present findings, that the facilitating effect of prospection on PM is greater when the future scenario associated to the realisation of an intended action is simulated in an episodic manner, the results of the experiments concerning the temporal component of EFT (Chapter 7) seem to favour this possibility. They indeed showed that simulating to perform a PM task in the near future produces more benefits to prospective remembering as compared to

imagining to perform the same task in the distant future. As observed in Chapter 1, the temporal distance of future events strongly affects the characteristics and representational format of a future representation. That is, distant future events tend to reflect more abstract (semanticised) form of prospection (Chapter 1; see also Szpunar et al., 2014) and tend to be represented in less details compared to near future events (e.g., Trope & Liberman, 2003). And, indeed, in Chapter 7 it was observed that when participants imagined performing the PM in the distant future, their representations contained less internal (episodic) details compared to when they simulated to perform the same task in the near future. This consideration seems therefore to support the claim that the level of specificity of future simulation plays a key role in enhancing prospective remembering, over and above simply imagining to perform a future action.

A further, related source of evidence favouring this view can be traced in research differentiating between the efficacy of ‘outcome simulation’ and ‘process simulation’ in promoting goal’s achievement. An outcome simulation is a more generalised form of simulation associated with imagining the instance in which one can achieve his/her goal and the positive feelings associated with this achievement. Process simulation, on the other hand, emphasises the mental representation of all the steps needed to achieve one’s future goal (Taylor & Pham, 1998). That is, rather than imagining oneself in the desired state, which might bring momentary satisfaction, one would envision the necessary steps required to achieve a future goal (Taylor & Pham, 1998). Generally, it appears that simulating the process of working toward a future outcome is most functional than simply imagining goal’s achievement (Szpunar, 2010).

Together, this evidence raises the possibility that, although forming an intention does not necessarily require one to think about the event in a specific manner, constructing a detailed representation of the situation associated to the realisation of the delayed action provides a considerable benefit for carrying out future behaviour.

An interesting avenue for future research could be to explore whether other future-oriented tasks may also benefit from the use of prospection and to what extent this possible facilitating effect depends on the ability to imagine the future in a specific

manner. In particular, while the studies discussed in this thesis revealed that EFT may be an effective encoding strategy to successfully accomplish PM tasks, other studies showed that decision making tasks can be instead effectively performed without imagining a future scenario in details (e.g., Kwan et al., 2012; Kwan et al., 2013).

In summary, these observations suggest that, rather than studying the different future-oriented processes in isolation from one another, it would be important to investigate how they interact to produce more sophisticated prospection capacities (Spzunar & Tulving, 2011).

8.4 Conclusions

In conclusion, the results of this dissertation contribute to develop novel theories of human prospection and to define new areas within which future simulation can be used to increase individuals' psychological and functional wellbeing.

At a theoretical level, the studies discussed in this thesis strengthen the view of prospection as a complex, multifaceted phenomenon that impinges upon a constellation of constituent abilities, which may be adaptively used to anticipate and guide future behaviour. In particular, they highlight the contribution of different types of memory and cognitive functions to future simulation, thus suggesting that theoretical models of prospection should also consider the contribution of non-episodic processes.

At a methodological level, the First Part of this thesis revealed that particular factors, such as the type of cues used to elicit prospection, the temporal distance and the valence of future events can strongly influence the characteristics and representational format of imagined future scenes. This can be instrumental for designing novel experimental paradigms aiming at specifically assessing different forms of prospection.

The results of the studies discussed in the Second Part revealed that a task requiring descriptions of visually presented pictures (as the ones used in Chapters 3 and 4) may represent a valuable control condition in studies examining prospection abilities. The inclusion of such a task may, in fact, allow researchers to separate and elucidate the contribution of narrative abilities to the performance in traditional tasks used to study prospection. Additionally, the observation that narrative construction difficulties are more likely to emerge when the scene to be described is sufficiently complex to tax memory or other compromised functions may serve to develop new paradigms assessing the role of other cognitive systems, such as the episodic buffer, in the construction of imagined future scenes.

From a clinical perspective, the results of this thesis contribute to shed additional light on the nature and extent of prospection deficits in older adults and amnesic patients. Specifically, they suggest that difficulties and/or deficits in the traditional tasks used to study prospection are not exclusive consequence of an impaired capacity to access details from past memories to simulate future events, but also reflect an inability to collect and assemble or relate disparate details into a coherent scene or narrative (Hassabis et al., 2007; Rosenbaum et al., 2009; Schacter & Addis, 2009). These findings, therefore, support the claim that the capacity to construct an imagined future scenario can be affected by different basic and dissociable processes that might have been confounded with each other in previous work, and only some of which appear to depend on the ability to mentally travel through time (Kwan et al., 2013). Consistent with this possibility, initial evidence suggests that the inability to construct future scenes does not preclude individuals with episodic memory deficits from making reasonable decisions about the future (e.g., Kwan et al., 2012). Thus, at least in some instances, the temporal and the constructive component of prospection may be dissociable. Specifically elucidating the source of prospection difficulties in people with difficulties and/or deficits in memory, may help clinicians either detect more specific prospection deficits, and establish new targets for rehabilitation treatments aiming at recovering, whenever possible, or strengthening prospection abilities by leveraging on the spared cognitive functions (e.g., semantic memory, e.g., Klein et al., 2002, Klein, 2013).

Finally, at an applied level, the results of the Third Part of this dissertation provide an empirical support to the hypothesis that future event simulation increases the chance of promptly performing a prospective action, thus extending the functional benefits arising from future simulation in everyday life. Furthermore, they suggest that the way in which a future scenario is simulated (i.e., more or less congruent with the real future event, more or less specific) can modulate the effect of EFT on future-oriented behaviour. These observations may help develop specific trainings, based on the use of future simulation, aiming at improving prospective memory in everyday life.

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References

- Addis, D. R., Musicaro, R., Pan, L., & Schacter, D. L. (2010). Episodic simulation of past and future events in older adults: Evidence from an experimental recombination task. *Psychology and Aging, 25*, 369–376.
- Addis, D. R., Pan, L., Vu, M. A., Laiser, N., & Schacter, D. L. (2009). Constructive episodic simulation of the future and the past: Distinct subsystems of a core brain network mediate imagining and remembering. *Neuropsychologia, 47*, 2222–2238.
- Addis, D. R., Sacchetti, D. C., Ally, B. A., Budson, A. E., & Schacter, D. L. (2009). Episodic simulation of future events is impaired in mild Alzheimer's disease. *Neuropsychologia, 47*, 2660–2671.
- Addis, D. R., Wong, A. T., & Schacter, D. L. (2007). Remembering the past and imagining the future: Common and distinct neural substrates during event construction and elaboration. *Neuropsychologia, 45*, 1363–1377.
- Addis, D. R., Wong, A. T., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science, 19*, 33–41.
- Adelman, F., Hoofien, D., Goldberg, I., Aizenstein, O., & Neufeld, M. Y. (2010). Bilateral hippocampal lesion and a selective impairment of the ability for mental time travel. *Neurocase, 16*, 426–435.
- Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in cognitive sciences, 5*, 533–539.
- Atance, C. M., & O'Neill, D. K. (2005). The emergence of episodic future thinking in humans. *Learning and Motivation, 36*, 126–144.
- Baddeley, A. (2000). The episodic buffer: a new component of working memory?. *Trends in cognitive sciences, 4*, 417–423.
- Baddeley, A., & Wilson, B. A. (2002). Prose recall and amnesia: Implications for the structure of working memory. *Neuropsychologia, 40*, 1737–1743.
- Bar, M. (2007). The proactive brain: using analogies and associations to generate predictions. *Trends in cognitive sciences, 11*, 280–289.
- Bar, M. (2009). Predictions: A universal principle in the operation of the human brain (Introduction). *Philosophical Transactions of the Royal Society B, 364*, 1181–1182.
- Basso A, Capitani E, and Laiacona M. Raven's coloured progressive matrices: Normative values on 305 adult normal controls. *Functional Neurology, 2*, 189 and 194, 1987.
- Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*, 323–370.

- Benoit, R. G., Gilbert, S. J., & Burgess, P. W. (2011). A neural mechanism mediating the impact of episodic prospection on farsighted decisions. *The Journal of Neuroscience*, 31, 6771-6779.
- Berntsen, D. (2009). *Involuntary autobiographical memories. An introduction to the unbidden past*. Cambridge: Cambridge University Press.
- Berntsen, D., & Bohn, A. (2010). Remembering and forecasting: The relation between autobiographical memory and episodic future thinking. *Memory and Cognition*, 38, 265–278.
- Berntsen, D., & Jacobsen, A. S. (2008). Involuntary (spontaneous) mental time travel into the past and future. *Consciousness and Cognition*, 17, 1093–1104.
- Berntsen, D., & Rubin, D. C. (2004). Cultural life scripts structure recall from autobiographical memory. *Memory and Cognition*, 32, 427-442.
- Berryhill, M. E., Picasso, L., Arnold, R., Drowos, D., & Olson, I. R. (2010). Similarities and differences between parietal and frontal patients in autobiographical and constructed experience tasks. *Neuropsychologia*, 48, 1385–1393
- Boyer, P. (2008). Evolutionary economics of mental time travel?. *Trends in cognitive sciences*, 12, 219-224.
- Brandimonte, M. A., Einstein, G. O., & McDaniel, M. A.. (1996). *Prospective memory: Theory and applications*. Psychology Press.
- Brandimonte, M. A., & Ferrante, D. (2008). The social side of prospective memory. In M. Kleigel, M. A. McDaniel, & G. O. Einstein (Eds.), *Prospective memory: Cognitive, neuroscience, development, and applied perspectives*. New York: Erlbaum, 347-364.
- Brandimonte, M. A., Ferrante, D., Bianco, C., & Villani, M. G. (2010). Memory for pro-social intentions: When competing motives collide. *Cognition*, 114, 436-441.
- Brandimonte, M. A, Ferrante D., Feresin C., & Delbello R. (2001). Dissociating prospective memory from vigilance processes. *Psicologica. Journal of Methodology and Experimental Psychology*, 22, 97-113.
- Brandimonte, M. A., & Passolunghi, M. C. (1994). The effect of cue-familiarity, cue-distinctiveness, and retention interval on prospective remembering. *The Quarterly Journal of Experimental Psychology*, 47, 565-587.
- Brewer, G. A., Knight, J., Thadeus Meeks, J., & Marsh, R. L. (2011). On the role of imagery in event-based prospective memory. *Consciousness and Cognition*, 20, 901-907.
- Brewer, G. A., Marsh, R. L., Clark-Foos, A., Meeks, J.T. Cook, G.I., Hicks, J.L. A comparison of activity-based to event-based prospective memory. *Applied Cognitive Psychology*, 25, 632-640.

- Brown, A. D., Addis, D. R., Romano, T. A., Marmar, C. R., Bryant, R. A., Hirst, W., & Schacter, D. L. (2014). Episodic and semantic components of autobiographical memories and imagined future events in post-traumatic stress disorder. *Memory*, 22, 595-604
- Brown, G. P., MacLeod, A. K., Tata, P. & Goddard, L. (2002). Worry and the simulation of future outcomes. *Anxiety, Stress and Coping*, 15, 1-17.
- Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in cognitive sciences*, 11, 49-57.
- Buehler, R., Griffin, D., & Peetz, J. (2010). The planning fallacy: Cognitive, motivational, and social origins. In M. P. Zanna & J. M. Olson (Eds.), *Advances in experimental social psychology* San Diego, CA: *Academic Press*, 1-62.
- Burani, C., Barca, L., & Arduino, L. S. (2001). Una base di dati sui valori di età di acquisizione, frequenza, familiarità, immaginabilità, concretezza, e altre variabili lessicali e sublessicali per 626 nomi dell'Italiano. *Giornale Italiano di Psicologia*, 4, 839-856.
- Burgess, P. W., Quayle, A., & Frith, C. D. (2001). Brain regions involved in prospective memory as determined by positron emission tomography. *Neuropsychologia*, 39, 545-555.
- Busby, J., & Suddendorf, T. (2005). Recalling yesterday and predicting tomorrow. *Cognitive Development*, 20, 362-372.
- Cabeza, R. (2002). Hemispheric asymmetry reduction in older adults: the HAROLD model. *Psychology and Aging*, 17, 85.
- Carlesimo G.A., Buccione I., Fadda L., Graceffa A., Mauri M., Lo Russo S. (2002). Standardizzazione di due test di memoria per uso clinico: Breve racconto e Figura di Rey. *Nuova Rivista di Neurologia*, 12, 3-13.
- Carlesimo, G. A., Caltagirone, C., Gainotti, G. U. I. D. O., Fadda, L., Gallassi, R., Lorusso, S., et al. (1996). The mental deterioration battery: normative data, diagnostic reliability and qualitative analyses of cognitive impairment. *European neurology*, 36, 378-384.
- Capasso, R., & Miceli, G. (2001). *Esame Neuropsicologico per l'Afasia: ENPA* (Vol. 4). Springer.
- Caspari, I., & Parkinson, S. R. (2000). Effects of memory impairment on discourse. *Journal of Neurolinguistics*, 13, 15-36.
- Christian, B. M., Miles, L. K., Fung, F. H. K., Best, S., & Macrae, C. N. (2013). The shape of things to come: Exploring goal-directed prospection. *Consciousness and Cognition*, 22, 471-478.
- Cicogna P. C., Nigro G., Occhionero M., & Esposito M. J. (2005). Time-based prospective remembering: interference and facilitation in a dual task. *European Journal of Cognitive Psychology*, 17, 221-240.

- Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological review*, 107, 261.
- Cooper, J. M., Vargha-Khadem, F., Gadian, D. G., & Maguire, E. A. (2011). The effect of hippocampal damage in children on recalling the past and imagining new experiences. *Neuropsychologia*, 49, 1843-1850.
- Coupland, J. (2009). Discourse, identity and change in mid-to-late life: interdisciplinary perspectives on language and ageing. *Ageing and Society*, 29, 849-861.
- Crovitz, H. F., & Schiffman, H. (1974). Frequency of episodic memories as a function of their age. *Bulletin of the Psychonomic Society*, 4, 517-518.
- D'Argembeau, A., & Demblon, J. (2012). On the representational systems underlying prospection: Evidence from the event-cueing paradigm. *Cognition*, 125, 160-167.
- D'Argembeau, A., Lardi, C., & Van der Linden, M. (2012). Self-defining future projections: Exploring the identity function of thinking about the future. *Memory*, 20, 110-120.
- D'Argembeau, A., & Mathy, A. (2011). Tracking the construction of episodic future thoughts. *Journal of Experimental Psychology: General*, 140, 258-271.
- D'Argembeau, A., Ortoleva, C., Jumentier, S., & Van der Linden, M. (2010). Component processes underlying future thinking. *Memory and Cognition*, 38, 809-819.
- D'Argembeau, A., Raffard, S., & Van der Linden, M. (2008). Remembering the past and imagining the future in schizophrenia. *Journal of abnormal psychology*, 117, 247.
- D'Argembeau, A., Renaud, O., & Van der Linden, M. (2011). Frequency, characteristics and functions of future-oriented thoughts in daily life. *Applied Cognitive Psychology*, 25, 96-103.
- D'Argembeau, A., & Van der Linden, M. (2004). Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and Cognition*, 13, 844-858.
- D'Argembeau, A., & Van der Linden, M. (2006). Individual differences in the phenomenology of mental time travel: The effect of vivid visual imagery and emotion regulation strategies. *Consciousness and Cognition*, 15, 342-350.
- Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York: Harcourt Brace.
- De Hériz, Enrique (2006). *Bugia*. Dalai Editore.

- de Vito, S. (2012). The beyond within. *Cortex*, 48, 781–784.
- de Vito, S., & Della Sala, S. (2011). Predicting the future. *Cortex*, 47, 1018–1022.
- de Vito, S., Gamboz, N., & Brandimonte, M. A. (2012). What differentiates episodic future thinking from complex scene imagery?. *Consciousness and Cognition*, 21, 813-823.
- de Vito, S., Gamboz, N., & Brandimonte, M.A., Barone, P., Amboni, M., & Della Sala, S. (2012). Future thinking in Parkinson's Disease: an executive function? *Neuropsychologia*, 50, 1494-501.
- de Vito, S., Neroni, M. A., Gamboz, N., Della Sala, S., & Brandimonte, M. A. (2014). Desirable and undesirable future thoughts call for different scene construction processes. *The Quarterly Journal of Experimental Psychology*, (ahead-of-print), 1-8.
- Della Sala, S., MacPherson, S. E., Phillips, L. H., Sacco, L., & Spinnler, H. (2003). How many camels are there in Italy? Cognitive estimates standardised on the Italian population. *Neurological Sciences*, 24, 10-15.
- Dismukes, R. K. (2010). Remembrance of things future: prospective memory in laboratory, workplace, and everyday settings. *Reviews of human factors and ergonomics*, 6, 79-122.
- Dritschel, B. H., Williams, J. M. G., Baddeley, A. D., & Nimmo-Smith, I. (1992). Autobiographical fluency: A method for the study of personal memory. *Memory and Cognition*, 20, 133-140.
- Eichenbaum, H. *Memory, amnesia, and the hippocampal system*, 1993. Cambridge, MIT Press.
- Einstein, G. O., Holland, L. J., McDaniel, M. A., & Gynn, M. J. (1992). Age-related deficits in prospective memory: The influence of task complexity. *Psychology and Aging*, 7, 471.
- Einstein, G. O., & McDaniel, M. A. (2005). Prospective memory multiple retrieval processes. *Current Directions in Psychological Science*, 14, 286-290.
- Einstein, G. O., McDaniel, M. A., Manzi, M., Cochran, B., & Baker, M. (2000). Prospective memory and aging: Forgetting intentions over short delays. *Psychology and Aging*, 15, 671-683.
- Einstein, G. O., McDaniel, M. A., Marsh, R. L., West, R., & John, H. B. (2008). Prospective memory: Processes, lifespan changes, and neuroscience. *Cognitive psychology of memory*, 2, 867-892.
- Einstein, G. O., McDaniel, M. A., Thomas, R., Mayfield, S., Shank, H., Morrisette, N., & Breneiser, J. (2005). Multiple processes in prospective memory retrieval: factors determining monitoring versus spontaneous retrieval. *Journal of Experimental Psychology: General*, 134, 327-341.

- Ellis, J. (1996). Prospective memory or the realization of delayed intentions: A conceptual framework for research. *Prospective memory: Theory and applications*, 1-22.
- Ellis, J. A., & Freeman, J. E. (2008). Ten years on: Realizing delayed intentions.
- Erez, J., Lee, A. C., & Barense, M. D. (2013). It does not look odd to me: Perceptual impairments and eye movements in amnesic patients with medial temporal lobe damage. *Neuropsychologia*, 51, 168-180.
- Falk, Dan. *In Search of Time: The Science of a Curious Dimension*. Macmillan, 2008.
- Gamboz, N., Brandimonte, M. A., & de Vito, S. (2010). The role of past in the simulation of autobiographical future episodes. *Experimental psychology*, 57, 419-428.
- Gamboz, N., de Vito, S., Brandimonte, M.A., Pappalardo, S., Galeone, F., Iavarone, A., & Della Sala, S. (2010). Episodic future thinking in amnesic mild cognitive impairment. *Neuropsychologia*, 48, 2091-2097.
- Gaesser, B., Sacchetti, D. C., Addis, D. R., & Schacter, D. L. (2011). Characterizing age-related changes in remembering the past and imagining the future. *Psychology and Aging*, 26, 80.
- Gilbert, D. T., & Wilson, T. D. (2007). Prospection: experiencing the future. *Science*, 317, 1351-1354.
- Gilbert, D. T., & Wilson, T. D. (2009). Why the brain talks to itself: Sources of error in emotional prediction. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364, 1335-1341.
- Giovagnoli, A. R., Del Pesce, M., Mascheroni, S., Simoncelli, M., Laiacina, M., & Capitani, E. (1996). Trail making test: normative values from 287 normal adult controls. *The Italian journal of neurological sciences*, 17, 305-309.
- Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European review of social psychology*, 4, 141-185.
- Gollwitzer, P. M. (1999). Implementation intentions: strong effects of simple plans. *American Psychologist*, 54, 493.
- Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, 38, 69-119.
- Gordon R. An investigation into some of the factors that favour the formation of stereotyped images. *The British Journal of Psychology*, 39: 156 and 167, 1949.
- Graham, K. S., Barense, M. D., & Lee, A. C. (2010). Going beyond LTM in the MTL: a synthesis of neuropsychological and neuroimaging findings on the role of the medial temporal lobe in memory and perception. *Neuropsychologia*, 48, 831-853.

- Greenberg, D. L., & Verfaellie, M. (2010). Interdependence of episodic and semantic memory: evidence from neuropsychology. *Journal of the International Neuropsychological society*, 16, 748-753.
- Henry, J. D., MacLeod, M. S., Phillips, L. H., & Crawford, J. R. (2004). A meta-analytic review of prospective memory and aging. *Psychology and Aging*, 19, 27.
- Haith, M. M. (1998). Who put the cog in infant cognition? Is rich interpretation too costly? *Infant Behavior and Development*, 21, 167-17.
- Harwood, J., Giles, H., & Ryan, E. B. (1995). Aging, communication, and intergroup theory: Social identity and intergenerational communication. In J. F. Nussbaum & J. Coupland (Eds.), *Handbook of communication and aging research* (pp.133-159). Hillsdale, NJ: Erlbaum.
- Hasher, L., Zacks, R. T., & May, C. P. (1999). Inhibitory control, circadian arousal, and age. In D. Gopher & A. Koriati (Eds.), *Attention and Performance XVII, Cognitive Regulation of Performance: Interaction of Theory and Application* (pp. 653-675). Cambridge, MA: MIT Press.
- Hassabis, D., Kumaran, D., & Maguire, E. A. (2007). Using imagination to understand the neural basis of episodic memory. *The Journal of neuroscience*, 27, 14365-14374.
- Hassabis, D., Kumaran, D., Vann, S. D., & Maguire, E. A. (2007). Patients with hippocampal amnesia cannot imagine new experiences. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 1726–1731.
- Hassabis, D., & Maguire, E. A. (2007). Deconstructing episodic memory with construction. *Trends in Cognitive Sciences*, 11, 299–306.
- Hassabis, D., & Maguire, E. A. (2009). The construction system of the brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364, 1263-1271.
- Ingvar, D. H. (1979). "Hyperfrontal" distribution of the cerebral grey matter flow in resting wakefulness; on the functional anatomy of the conscious state. *Acta Neurologica Scandinavica*, 60, 12-25.
- Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Considering the role of semantic memory in episodic future thinking: Evidence from semantic dementia. *Brain*, 135, 2178–2191.
- Irish, M., & Piguet, O. (2013). The pivotal role of semantic memory in remembering the past and imagining the future. *Frontiers in Behavioral Neuroscience*, 7, 1–11.
- James, L. E., Burke, D. M., Austin, A., & Hulme, E. (1998). Production and perception of " verbosity" in younger and older adults. *Psychology and Aging*, 13, 355.
- Janoff-Bulman, R. (1989). Assumptive worlds and the stress of traumatic events: Applications of the schema construct. *Social Cognition*, 7, 113–136.

- Kahneman, D., & Tversky, A. (1982). The simulation heuristic. In D. Kahneman, P. Slovic & A. Tversky (Eds.), *Judgment under uncertainty* (pp. 201–208). Cambridge, United Kingdom: *Cambridge University Press*.
- Kassam, K. S., Gilbert, D. T., Boston, A., & Wilson, T. D. (2008). Future anhedonia and time discounting. *Journal of Experimental Social Psychology*, 44, 1533-1537.
- Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A., & Jaffe, M. W. (1963). Studies of illness in the aged: the index of ADL: a standardized measure of biological and psychosocial function. *Jama*, 185, 914-919.
- Klein, S. B. (2013). The complex act of projecting oneself into the future. *Wiley Interdisciplinary Reviews: Cognitive Science*, 4, 63–79.
- Klein, S. B., Loftus, J., & Kihlstrom, J. F. (2002). Memory and temporal experience: The effects of episodic memory loss on an amnesic patient's ability to remember the past and imagine the future. *Social Cognition*, 20, 353–379.
- Klinger, E., & Cox, W. M. (1987). Dimensions of thought flow in everyday life. *Imagination, Cognition and Personality*, 7, 105-128.
- Kliegel, M., Martin, M., McDaniel, M. A., & Einstein, G. O. (2001). Varying the importance of a prospective memory task: Differential effects across time-and event-based prospective memory. *Memory*, 9, 1-11.
- Kliegel, M., Martin, M., McDaniel, M., & Einstein, G. (2004). Importance effects on performance in event-based prospective memory tasks. *Memory*, 12, 553-561.
- Kliegel, M., McDaniel, M. A., & Einstein, G. O. (2008). *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives*. New York, NY: Taylor & Francis Group.
- Kushlev, K., & Dunn, E. W. (2011). Affective forecasting: Knowing how we will feel in the future. In S. Vazire & T. D. Wilson (Eds.), *Handbook of self-knowledge*. New York, NY: Guilford Press.
- Kwan D., Carson N., Addis D.R., and Rosenbaum R.S.(2010). Deficits in past remembering extend to future imagining in a case of developmental amnesia. *Neuropsychologia*, 48, 3179-3186.
- Kwan, D., Craver, C.F., Green, L., Myerson, J., Boyer, P., & Rosenbaum, R., S. (2012). Future decision-making without episodic mental time travel. *Hippocampus*, 22, 1215-1219.
- Kwan, D., Craver, C. F., Green, L., Myerson, J., & Rosenbaum, R. S. (2013). Dissociations in future thinking following hippocampal damage: Evidence from discounting and time perspective in episodic amnesia. *Journal of Experimental Psychology: General*, 142, 1355.
- Lazzari, R., & Pancheri, P. (1980). Questionario di valutazione dell'ansia di stato e di tratto (State-Trait Anxiety Inventory). *Organizzazioni Speciali, Firenze*.

- Leitz, J.R., Morgan, C.J.A., Bisby, J.A., Rendell, P.G., & Curran, H.V. (2009). Global impairment of prospective memory following acute alcohol. *Psychopharmacology*, 205, 379-387.
- Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and aging*, 17, 677-689.
- Liberman, N., & Trope, Y. (1998). The role of feasibility and desirability considerations in near and distant future decisions: A test of temporal construal theory. *Journal of personality and social psychology*, 75, 5.
- Liberman, N., Trope, Y., & Stephan, E. (2007). Psychological distance. *Social psychology: Handbook of basic principles*, 2, 353-383.
- Lind, S. E., & Bowler, D. M. (2010). Episodic memory and episodic future thinking in adults with autism. *Journal of abnormal psychology*, 119, 896.
- Linton, M. (1986). Ways of searching and the contents of memory. *Autobiographical memory*, 50- 67.
- Loewenstein, G., O'Donoghue, T., & Rabin, M. (2003). Projection Bias In Predicting Future Utility. *Quarterly Journal of Economics*, 118, 1209-1248.
- Mackenzie, C., Brady, M., Norrie, J., & Poedjianto, N. (2007). Picture description in neurologically normal adults: Concepts and topic coherence. *Aphasiology*, 21, 340-354.
- MacLeod, A. K., & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of Abnormal Psychology*, 105, 286-289.
- MacLeod, A. K., & Conway, C. (2007). Well-being and positive future thinking for self versus others. *Cognition and Emotion*, 21, 1114-1124.
- MacLeod, A. K., Rose, G. S., & Williams, J. M. G. (1993). Components of hopelessness about the future in parasuicide. *Cognitive Therapy and Research*, 17, 441-455.
- MacLeod, A. K., & Salaminiou, E. (2001). Reduced positive future-thinking in depression: Cognitive and affective factors. *Cognition and Emotion*, 15, 99-107.
- Madore, K. P., Gaesser, B., & Schacter, D. L. (2013). Constructive episodic simulation: Dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40, 609-622.
- Maguire, E. A., & Hassabis, D. (2011). Role of the hippocampus in imagination and future thinking. *Proceedings of the National Academy of Sciences*, 108, E39-E39.
- Maguire, E. A., & Mullally, S. L. (2013). The hippocampus: A manifesto for change. *Journal of Experimental Psychology: General*, 142, 1180.

- Maguire, E. A., Vargha-Khadem, F., & Hassabis, D. (2010). Imagining fictitious and future experiences: evidence from developmental amnesia. *Neuropsychologia*, 48(11), 3187-3192.
- Marks DF. Visual imagery differences in the recall of pictures. *British Journal of Psychology*, 64: 17 and 24, 1973.
- Marsh, R. L., Hicks, J. L., & Landau, J. D. (1998). An investigation of everyday prospective memory. *Memory and Cognition*, 26, 633-643.
- McDaniel, M. A., & Einstein, G. O. (1993). The importance of cue familiarity and cue distinctiveness in prospective memory. *Memory*, 1, 23-41.
- McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied cognitive psychology*, 14, S127-S144.
- McDaniel, M. A., & Einstein, G. O. (2007). *Prospective memory: An overview and synthesis of an emerging field*. Sage Publications, Incorporated.
- McDaniel, M. A., Guynn, M. J., Einstein, G. O., & Breneiser, J. (2004). Cue-focused and reflexive-associative processes in prospective memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30, 605-613.
- McDaniel, M. A., Howar, D. C., & Butler, K. M. (2008). Implementation intentions facilitate prospective memory under high attention demands. *Memory and Cognition*, 36, 716-724.
- McGaugh, J. L. (2004). The amygdala modulates the consolidation of memories of emotionally arousing experiences. *Annual Review of Neuroscience*, 27, 1–28.
- MacLeod, A. K., & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of abnormal psychology*, 105(2), 286.
- MacLeod, A. K., & Conway, C. (2007). Well-being and positive future thinking for the self versus others. *Cognition and Emotion*, 21(5), 1114-1124.
- Morris, J. C. (1993). The Clinical Dementia Rating (CDR): current version and scoring rules. *Neurology*.
- Nelson, H. E. (1982). National Adult Reading Test (NART): *For the assessment of premorbid intelligence in patients with dementia: Test manual*. NFER-Nelson.
- Neroni, M. A., Gamboz, N., & Brandimonte, M. A. (2014). Does episodic future thinking improve prospective remembering? *Consciousness and Cognition*, 23, 53-62.
- Newby-Clark, I. R., & Ross, M. (2003). Conceiving the past and future. *Personality and Social Psychology Bulletin*, 29, 807–818.

- Newby-Clark, I. R., Ross, M., Buehler, R., Koehler, D. J., & Griffin, D. (2000). People focus on optimistic scenarios and disregard pessimistic scenarios while predicting task completion times. *Journal of Experimental Psychology: Applied*, 6, 171–182.
- Nigro, G., Brandimonte, M. A., Cicogna, P., & Cosenza, M. (2013). Episodic future thinking as a predictor of children's prospective memory. *Journal of experimental child psychology*.
- Okuda, J., Fujii, T., Ohtake, H., Tsukiura, T., Tanji, K., Suzuki, K., et al. (2003). Thinking of the future and the past: The roles of the frontal pole and the medial temporal lobes. *Neuroimage*, 19, 1369-1380.
- Orbeil, S., Hodgkins, S., & Sheeran, P. (1997). Implementation intentions and the theory of planned behavior. *Personality and Social Psychology Bulletin*, 23, 945-954.
- Orsini A, Grossi D, Capitani E, Laiacona M, Papagno C, and Vallar G. Verbal and spatial immediate memory span: Normative data from 1355 adults and 1112 children. *The Italian Journal of Neurological Sciences*, 8: 537 and 548, 1987.
- Paraskevaides, T., Morgan, C. J., Leitz, J. R., Bisby, J. A., Rendell, P. G., & Curran, H. V. (2010). Drinking and future thinking: acute effects of alcohol on prospective memory and future simulation. *Psychopharmacology*, 208, 301-308.
- Parkin, A. J., Bell, W. P., & Leng, N. R. (1988). A study of metamemory in amnesic and normal adults. *Cortex*, 24, 143-148.
- Pedrabissi, L., & Santinello, M. (1989). *Manuale dell'adattamento italiano dello STAI forma Y*. Firenze: Organizzazioni Speciali.
- Peters, J., & Büchel, C. (2010). Episodic future thinking reduces reward delay discounting through an enhancement of prefrontal-mediotemporal interactions. *Neuron*, 66, 138-148.
- Poppenk, J., Moscovitch, M., McIntosh, A. R., Ozcelik, E., & Craik, F. I. M. (2010). Encoding the future: Successful processing of intentions engages predictive brain networks. *Neuroimage*, 49, 905-913.
- Race, E., Keane, M. M., & Verfaellie, M. (2011). Medial temporal lobe damage causes deficits in episodic memory and episodic future thinking not attributable to deficits in narrative construction. *The Journal of Neuroscience*, 31, 10262-10269.
- Race, E., Keane, M. M., & Verfaellie, M. (2013). Losing sight of the future: Impaired semantic prospection following medial temporal lobe lesions. *Hippocampus*, 23, 268-277.
- Raz, N. (2000). Aging of the brain and its impact on cognitive performance: Integration of structural and functional findings. In: F.I.M. Craik and T.A. Salthouse (Eds.) *Handbook of Aging and Cognition* - II. (pp.1-90). Mahwah, NJ: Erlbaum.

- Rendell, P. G., Bailey, P. E., Henry, J. D., Phillips, L. H., Gaskin, S., & Kliegel, M. (2012). Older adults have greater difficulty imagining future rather than atemporal experiences. *Psychology and Aging*, 27, 1089.
- Rendell, P. G., & Craik, F. I. (2000). Virtual week and actual week. Age-related differences in prospective memory. *Applied Cognitive Psychology*, 14, S43-S62.
- Rendell, P. G., & Thomson, D. M. (1999). Aging and prospective memory: Differences between naturalistic and laboratory tasks. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 54, P256-P269.
- Ryan, J. D., Althoff, R. R., Whitlow, S., & Cohen, N. J. (2000). Amnesia is a deficit in relational memory. *Psychological Science*, 11, 454-461.
- Ryan, J. D., & Cohen, N. J. (2004). The nature of change detection and online representations of scenes. *Journal of Experimental Psychology: Human Perception and Performance*, 30, 988.
- Richardson A. Mental Imagery. London: Routledge and Keegan Paul, 1969.
- Romero, K., & Moscovitch, M. (2012). Episodic memory and event construction in aging and amnesia. *Journal of Memory and Language*, 67, 270-284.
- Rosenbaum, R. S., Gilboa, A., Levine, B., Winocur, G., & Moscovitch, M. (2009). Amnesia as an impairment of detail generation and binding: Evidence from personal, fictional, and semantic narratives in KC. *Neuropsychologia*, 47, 2181-2187.
- Schacter, D. L., & Addis, D. R. (2007). On the constructive episodic simulation of past and future events. *Behavioral and Brain Sciences*, 30, 331-332.
- Schacter, D. L., & Addis, D. R. (2009). On the nature of medial temporal lobe contributions to the constructive simulation of future events. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364, 1245-1253.
- Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events. *Annals of the New York Academy of Sciences*, 1124, 39-60.
- Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: Remembering, imagining, and the brain. *Neuron*, 76, 677-694.
- Schacter, D. L., Gaesser, B., & Addis, D. R. (2012). Remembering the past and imagining the future in the elderly. *Gerontology*, 59, 143-151.
- Seelye, A. M., Schmitter-Edgecombe, M., & Flores, J. (2010). Episodic memory predictions in persons with amnesic and non amnesic mild cognitive impairment. *Journal of clinical and experimental neuropsychology*, 32, 433-441.
- Sheldon, S., McAndrews, M. P., & Moscovitch, M. (2011). Episodic memory processes mediated by the medial temporal lobes contribute to open-ended problem solving. *Neuropsychologia*, 49, 2439-2447.

- Sherman, S. J., Cialdini, R. B., Schwartzman, D. F., & Reynolds, K. D. (1985). Imagining can heighten or lower the perceived likelihood of contracting a disease: The mediating effect of ease of imagery. *Personality and Social Psychology Bulletin*, 11, 118–127.
- Shimamura, A. P., & Squire, L. R. (1986). Memory and metamemory: a study of the feeling-of-knowing phenomenon in amnesic patients. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 12, 452.
- Shum, D., Valentine, M., & Cutmore, T. (1999). Performance of individuals with severe long-term traumatic brain injury on time-, event-, and activity-based prospective memory tasks. *Journal of Clinical and Experimental Neuropsychology*, 21, 49-58.
- Simons, J. S., Schölvinck, M. L., Gilbert, S. J., Frith, C. D., & Burgess, P. W. (2006). Differential components of prospective memory?: Evidence from fMRI. *Neuropsychologia*, 44, 1388-1397.
- Simons, J. S., & Spiers, H. J. (2003). Prefrontal and medial temporal lobe interactions in long-term memory. *Nature Reviews Neuroscience*, 4, 637-648.
- Smith, R. E. (2003). The cost of remembering to remember in event-based prospective memory: investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 29, 347.
- Smith, R. E., & Bayen, U. J. (2004). A Multinomial Model of Event-Based Prospective Memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30, 756-777.
- Smith, R. E., & Bayen, U. J. (2006). The source of adult age differences in event-based prospective memory: A multinomial modeling approach. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32, 623.
- Smith, R. E., Hunt, R. R., McVay, J. C., & McConnell, M. D. (2007). The cost of event-based prospective memory: Salient target events. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 33, 734.
- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. Consulting Psychologists Press; Palo Alto, CA: 1983. *Manual for the state-trait anxiety inventory (STAI)*.
- Szpunar, K. K., Addis, D. R., McLelland, V. C., & Schacter, D. L. (2013). Memories of the future: new insights into the adaptive value of episodic memory. *Frontiers in behavioral neuroscience*, 7.
- Szpunar, K. K., Spreng, R. N., & Schacter, D. L. (2014). A taxonomy of prospection: Introducing an organizational framework for future-oriented cognition. *Proceedings of the National Academy of Sciences*, 11, 18414-18421.

- Squire, L. R., van der Horst, A. S., McDuff, S. G., Frascino, J. C., Hopkins, R. O., & Mauldin, K.N. (2010). Role of the hippocampus in remembering the past and imagining the future. *Proceedings of the National Academy of Sciences*, 107, 19044-19048.
- Spreng, R. N., & Levine, B. (2006). The temporal distribution of past and future autobiographical events across the lifespan. *Memory and Cognition*, 34, 1644-1651.
- Suddendorf, T., & Corballis, M. C. (1997). Mental time travel and the evolution of the human mind. *Genetic, social, and general psychology monographs*, 123, 133-167.
- Szpunar, K. K. (2010). Episodic future thought: An emerging concept. *Perspectives on Psychological Science*, 5, 142-162.
- Szpunar, K. K. (2011). On subjective time. *Cortex*, 47, 409-411.
- Szpunar, K. K., & McDermott, K. B. (2008). Episodic future thought and its relation to remembering: Evidence from ratings of subjective experience. *Consciousness and Cognition*, 17, 330-334.
- Szpunar, K. K., & Schacter, D. L. (2013). Get real: Effects of repeated simulation and emotion on the perceived plausibility of future experiences. *Journal of Experimental Psychology: General*, 142, 323-327.
- Szpunar, K.K. & Tulving, E. (2011). Varieties of future experience. In Bar, M. (Ed.), *Predications in the brain: Using our past to generate a future* (pp. 3-12). New York: Oxford University Press.
- Szpunar, K. K., Watson, J. M., & McDermott, K. B. (2007). Neural substrates of envisioning the future. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 642-647.
- Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin*, 103, 193-210.
- Taylor, S. E., Pham, L. B., Rivkin, I. D., & Armor, D. A. (1998). Harnessing the imagination: Mental simulation, self-regulation, and coping. *American psychologist*, 53, 429.
- Taylor, S. E., & Schneider, S. K. (1989). Coping and the simulation of events. *Social cognition*, 7, 174-194.
- Tolstòj, L. (2003). *Anna Karenina*. New York: Barnes & Noble Classics. (Originally published on 1877).
- Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological review*, 110, 403..
- Uttl, B. (2005). Age-related changes in event-cued prospective memory proper. In *Dynamic cognitive processes* (pp. 273-303). Springer Tokyo.

- Warren, D. E., Duff, M. C., Tranel, D., & Cohen, N. J. (2010). Medial temporal lobe damage impairs representation of simple stimuli. *Frontiers in human neuroscience*, 4.
- Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology*, 43, 265-268.
- Wilson B., Cockburn J. and Halligan P.W.. Behavioural Inattention Test. *Bury St. Edmunds: Thames Valley*, 1987.
- Wheeler, M. A., Stuss, D. T., & Tulving, E. (1997). Toward a theory of episodic memory: the frontal lobes and autonoetic consciousness. *Psychological bulletin*, 121, 331.
- Zaleski, Z. E. (1994). *Psychology of future orientation*. Wydawnictwo Towarzystwa Naukowego Katolickiego Uniwersytetu Lubelskiego.
- Zeman, A. Z., Beschin, N., Dewar, M., & Della Sala, S. (2013). Imagining the present: Amnesia may impair descriptions of the present as well as of the future and the past. *Cortex*, 49, 637-645.
- Zimbardo, P. G., Keough, K. A., & Boyd, J. N. (1997). Present time perspective as a predictor of risky driving. *Personality and Individual Differences*, 23, 1007-1023

APPENDIX A

Set materials used in Chapter 2

Cue-words

Twenty cue-words were selected from the Burani, Barca, and Arduino (2001) Italian norms: dog, book, car, cat, water, bread, box, train, plane, table, bed, swimming pool, church, office, room, street, store, garden, party, house.

Short verbal sentences

Twenty future-oriented sentences: three sentences were taken from Hassabis et al. (2007, *) and seventeen additional sentences were obtained by slightly varying the structure of the Hassabis et al.'s ones.

1. * Imagine a possible and future meeting with a friend.
2. * Imagine a possible event occurring during Christmas time.
3. * Imagine a possible future event that might happen during the next weekend.
4. Imagine a possible and future meeting with a relative.
5. Imagine a possible and future meeting with your boyfriend/girlfriend.
6. Imagine a possible and future meeting with a yours school friend.
7. Imagine a possible and future meeting with a colleague.
8. Imagine a possible and future meeting with yours school teacher.
9. Imagine a possible event occurring during Easter time.
10. Imagine a possible New Year's Eve celebration.
11. Imagine a possible birthday party you might take part.
12. Imagine a possible wedding you might take part.
13. Imagine a future and possible next summer holiday.
14. Imagine a future and possible journey.
15. Imagine a future and possible working meeting.
16. Imagine a possible future event that might happen during in the next few days.
17. Imagine a possible future event that might happen within the next month.

18. Imagine a possible future event that might happen during the next year.
19. Imagine a possible future event that might happen during the next two five years.
20. Imagine a possible future event that might happen during the next two ten years.

Structured interview

1. What future period did your event refer to? (e.g., today, tomorrow, next week, next month, next year, more than the one next year)
2. Was this event detailed? (e.g. clearly contextualized, rich of images of people, objects and so forth) (1 = not at all; 7 = very detailed)
3. Did you find it was easy to think to this event? (i.e. as if it spontaneously come into your mind) (1 = not at all; 7 = very easily)
4. Is the content of this event important to you? (it deals with something important in your life) (1 = not at all; 7 = very important)
5. How often the same event, or a very similar one, happened to you in the past? (1 = never; 7 = very often)
6. Did you feel as you were living the event while imagining it? (1 = not at all; 7 = a lot)

APPENDIX B

Example of a description scored with the Levine et al. (2002) scoring method

The English transcript provided below is a translation of the original Italian transcript.

Time	Time	Place	Event	Event	Perceptual
It's winter, about 10 at night and I am in my bedroom, lied on my bed, still dealing with the book of Psychology.....					
External		Emotion/thought		Semantic	
I am doing my last exam tomorrow and I cannot put away this book and relax ... I am really anxious....					
Emotion/thought			Emotion/thought		
I'm really afraid I could miss some important information, maybe just the one the professor may ask me tomorrow....					
Perceptual		Perceptual		Perceptual	
My book looks very bad, with the pages filled of lines of different colors and full of sheet of papers with notes.....					
External			Perceptual		Perceptual
... the typical feature of my books when I am really close to the exams It is raining outside, it is really cold ...					
Event	Time	Event		Perceptual	
I continue to browse my book ... then, my mother comes into the room with a nice cup of hot chocolate ...					
Event		Event			
She gives me the advice to be not so afraid, and that I just need to go to sleep.....					
External			Event		Event
She knows how much I have studied for this exam... I tell her that I cannot relax and continue to browse my book					
Event					
while sipping the hot chocolate					

APPENDIX C

Materials used in Chapter 3

Cue-words

Twenty cue-words were selected from the Burani, Barca, and Arduino (2001) Italian norms: dog, book, car, cat, water, bread, box, train, plane, table, bed, swimming pool, church, office, room, street, store, garden, party, house.

APPENDIX D

Set materials used in Chapters 4 and 5

Imagined future scenarios

Simple a-temporal scenarios (Hassabis et al., 2007)

1. Imagine you are in an elevator in a small building.
2. Imagine you are working in a call center.
3. Imagine you are in a fitting room in a shop.

Complex a-temporal scenarios

1. Imagine you are lying on the white sandy beach of a tropical bay.
2. Imagine you are standing in the impressive main hall of a busy museum.
3. Imagine you are standing in the middle of a bustling street market.

Future scenarios (Hassabis et al., 2007)

1. Imagine a possible Christmas event.
2. Imagine a possible event over the next weekend.
3. Imagine a possible future meeting with a friend.

Extra cue (Hassabis et al., 2007)

Imagine you are sitting in a pub having a drink.

Pictures selected from Gaesser, Sacchetti, Addis, and Schacter (2011).



Pictures selected from Race, Keane, and Verfaellie (2011)



Four pictures with varying levels of complexity

Level 1



Level 2



Level 3



Level 4



Extra picture (used for the post-experimental interview)



APPENDIX E

Example of a description scored with the Hassabis et al. (2007) scoring method

SR	SD	EP	TEA
'I imagine being at this market, and it is very crowded, and people are pushing me...			
EP	TEA	TEA	TEA
there are people who are screaming to sell their things... at the beginning it is nice...			
TEA		TEA	
I start observing all the sellers, paying attention to what they are saying, the			
TEA		TEA	
expressions they are using...and I also observe the various people, what they are			
TEA	EP	TEA	
doing while looking at the various products....but then it all becomes tiring... there is			
EP	EP	EP	EP
a baby, a dog, an old woman, a seller who forces people to buy things...			
TEA	TEA	REPETITION	
I look only at the stalls that I like, because I cannot wait to go away, this crowd is so			
SD	IRRELEVANT	REP	
annoying.... It echoes in my head...I like more peaceful places...there are too many			
REP	TEA	TEA	
people and there are too many things to see...I feel lost...I cannot focus on what to			
REPETITION	TEA		
buy, it is not for me...too much noise... So I have a quick look around and			
TEA			
I go away...'			

APPENDIX F

Example of the Information Sheet and Consent Form used in the studies described in Chapters 4 and 5.

PARTICIPANT INFORMATION SHEET

PROJECT TITLE

Imagining the present: effect of scene complexity?

INVITATION

You are being asked to take part in a research study on describing the present and future thinking.

My name is Maria Adriana Neroni and I am a PhD student in Experimental Psychology and Cognitive Neuroscience at the University of Edinburgh. Together with my supervisor Prof. Sergio Della Sala, we are investigating some aspects of the links between the ability to imagine atemporal and future scenarios and the ability to report current experiences.

WHAT WILL HAPPEN

In this study, you will be asked to imagine and describe events on the basis of a short verbal cue read out to them by the experimenter and to describe printed pictures depicting people engaged in a particular activity or set of activities.

Your task will consist in imagining and describing the events and the pictures in as much detail as possible, without any time constraint. Your descriptions will be recorded and subsequently analysed with an appropriate scoring method.

TIME COMMITMENT

The study will take approximately 60 minutes.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point

be withdrawn/destroyed. You will still be paid for your contribution. You have the right to omit or refuse to answer or respond to any question that is asked of you.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

BENEFITS AND RISKS

There are no known benefits or risks for you in this study.

COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary.

CONFIDENTIALITY/ANONYMITY

The data collected during the experiment will be used for research purpose only and will remain anonymous. No one will link the data you provided to the identifying information you supplied (e.g., name, address, email).

The data could be used for publication or presentation at conferences but, if so, they will be not identifiable as yours.

FOR FURTHER INFORMATION

If you want to find out about the final results of this study, you should contact us in the next few months. Maria Adriana Neroni and Prof. Sergio Della Sala will be glad to answer your questions about this study at any time. You may contact them by email/phone:

Maria Adriana Neroni (mail: M.A.Neroni@sms.ed.ac.uk phone number: 07449795850)

Prof. Sergio Della Sala (mail: sergio@ed.ac.uk phone number: 0131 651 3242)

INFORMED CONSENT FORM

PROJECT TITLE

Imagining the present: effect of scene complexity?

By signing below, you are agreeing that:

- (1) you have read and understood the Participant Information Sheet,
- (2) questions about your participation in this study have been answered satisfactorily,
- (3) you are aware of the potential risks (if any), and

.....

Participant's Name (Printed)*

.....

Participant's signature*

.....

Date

Maria Adriana Neroni

.....

Name of person obtaining consent (Printed)
consent

.....

Signature of person obtaining
consent

*Participants wishing to preserve some degree of anonymity may use their initials
(from the British Psychological Society Guidelines for Minimal Standards of Ethical
Approval in Psychological Research)

APPENDIX G

Supplemental data (Experiments 4.2 and 4.3)

Perceived complexity of the pictures used in Experiments 4.2 and 4.3

In order to verify that the complexity criteria adopted in Experiments 4.2 and 4.3 were supported by the participants' subjective ratings, young and older participants were asked to rate, on a 5-point scale (i.e., 1 = very easy, 5 = very difficult), the perceived difficulty of the pictures previously described. This was done by showing the participants all four pictures again, one by one.

As shown in Figure F.1, no differences were observed between young and older adults' subjective ratings of the perceived complexity of either the Race-pictures, $t(26) = -.64$, $p = .53$, $\eta^2 = .015$, and the Gaesser-pictures, $t(26) = 1.15$, $p = .26$, $\eta^2 = .05$.

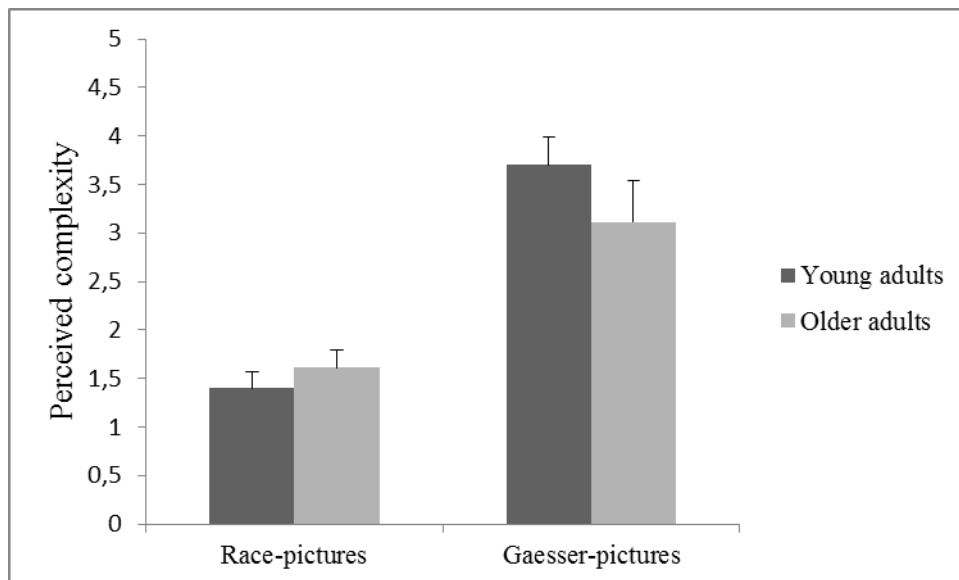


Figure F. 1. Participants' perceived complexity of the pictures adopted in Experiment 4.2

Furthermore, young and older adults did not statistically differ in their estimation of the complexity of the pictures of varying complexity (Level 1 : $t(26) = .77$, $p = .45$, $\eta^2 = .022$; Level 2: $t(26) = .79$, $p = .44$, $\eta^2 = .024$; Level 3: $t(26) = .05$, $p = .96$, $\eta^2 = .0001$; Level 4: $t(26) = 1.73$, $p = .10$, $\eta^2 = .11$).

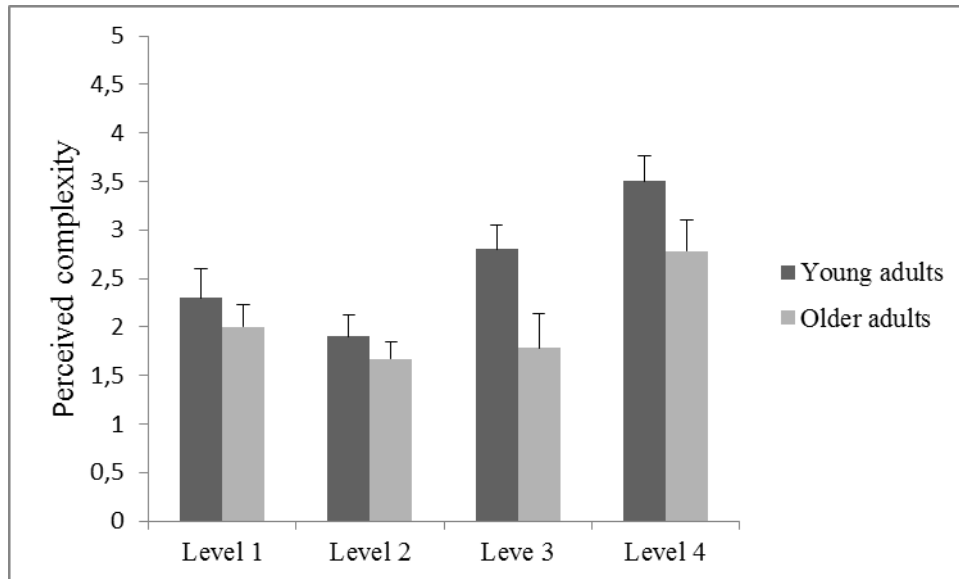


Figure F. 2. Participants' perceived complexity of pictures adopted in Experiment 4.3.

Post-experimental interview (Experiment 4.3)

At the end of the Experiment 4.3, young and older participants were asked to describe an extra picture (of average complexity level), according to the instructions provided in the previous pictures description tasks. Immediately after completing this last description, participants were engaged in a post-experimental interview in order to ascertain whether they adopted specific strategies in describing the extra picture.

The results revealed that young adults ($M = 48.64$, $SD = 17.8$) reported significantly more elements than older adults ($M = 32.5$, $SD = 23.44$) when described the extra pictures, $t(26) = 2.05$, $p = .05$, $\eta^2 = .16$.

Nevertheless, no significant differences were observed in the subjective ratings provided by young and older participants in the post-experimental interview.

Question 1: Did you think your description was detailed?

No significant group difference $p = 1$ (Fisher's exact test)

	YES	NO
Young adults	80%	20%
Older adults	80%	20%

Question 2: Did your description include all the items in the picture?

No significant group difference $p = .48$ (Fisher's exact test)

	YES	NO
Young adults	70%	30%
Older adults	40%	60%

Question 3: Did you find it was difficult to describe the picture?

No significant group difference $p = .57$ (Fisher's exact test)

	YES	NO
Young adults	50%	50%
Older adults	50%	50%

Question 4: Did you start by looking at the picture overall to get a general feeling?

No significant group difference $p = 0$ (Fisher's exact test)

	YES	NO
Young adults	100%	0%
Older adults	100%	0%

Question 5: Did you organize your description a bit before starting it?

No significant group difference $p = .45$ (Fisher's exact test)

	YES	NO
Young adults	50%	50%
Older adults	70%	30%

Question 6: Did you randomly select a detail to start with?

No significant group difference $p = .30$ (Fisher's exact test)

	YES	NO
Young adults	40%	60%
Older adults	70%	30%

APPENDIX H

Supplemental data (Chapter 5)

Perceived complexity of the pictures

In order to verify that the complexity criteria of the pictures adopted in Chapter 5 were supported by the participants' subjective ratings, patients and controls were asked to rate, on a 5-point scale (i.e., 1 = very easy, 5 = very difficult), the perceived difficulty of the pictures previously described. This was done by showing the participants all four pictures again, one by one.

As shown in Figure G.1, patients ($M = 1.8$, $SD = 1.25$) and controls ($M = 3.15$, $SD = .57$) did not statistically differ in their evaluation of the complexity of the Race-pictures, $t(18) = -1.94$, $p = .07$, $\eta^2 = .17$. In contrast, controls ($M = 4.25$, $SD = .75$) rated the Gaesser-pictures as more complex than did patients ($M = 1.85$, $SD = 1.2$), $t(18) = -3.12$, $p < .01$, $\eta^2 = .35$.

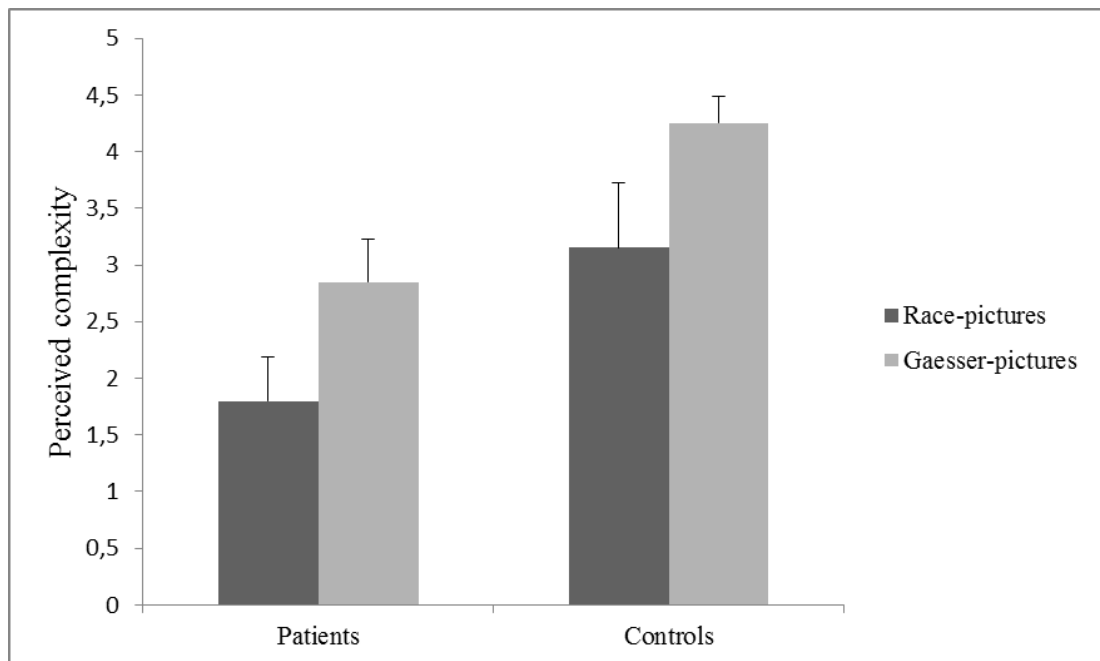


Figure G. 1. Participants' perceived complexity of the pictures used in Condition 5.2.2.2.1.

As shown in Figure G.2, controls overall rated the pictures of varying complexity as more complex than did patients [Level 1: $t(18) = -1.99$, $p = .06$, $\eta^2 = .18$; Level 2: $t(18) = -2.24$, $p < .05$, $\eta^2 = .22$; Level 3: $t(18) = -3.2$, $p = .005$, $\eta^2 = .36$; Level 4: $t(18) = -2.55$, $p < .05$, $\eta^2 = .26$].

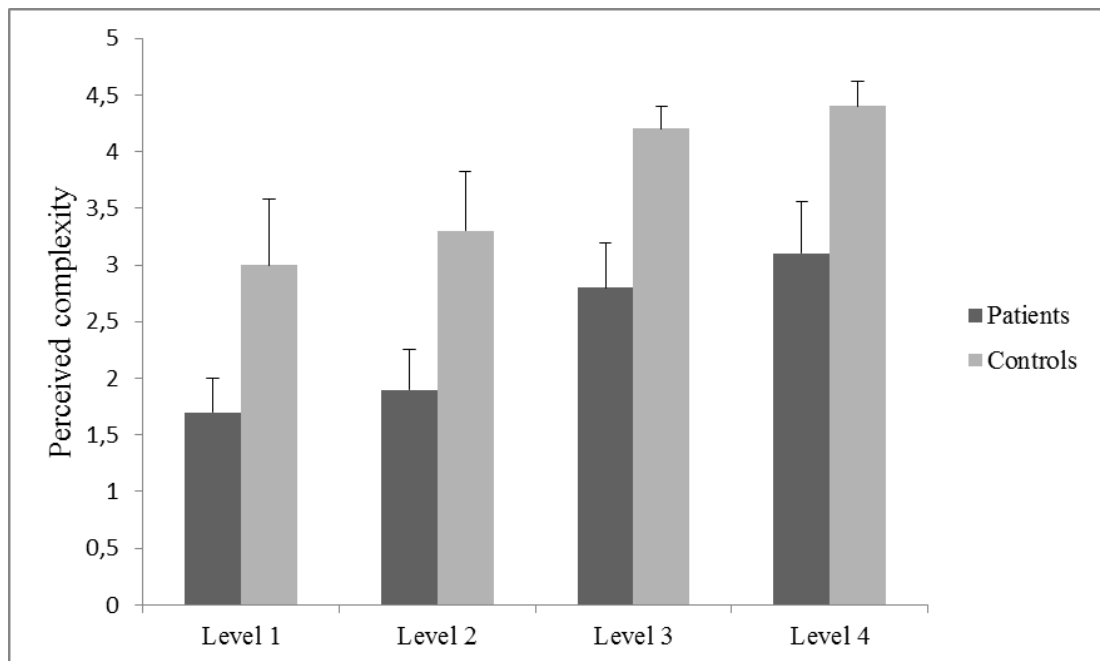


Figure G. 2. Participants' perceived complexity of the pictures used in Condition 5.2.2.2.2.

Post-experimental interview

At the end of the Experiment, patients and controls were asked to describe an extra picture (of average complexity level) according to the instructions provided in the Description of pictures condition. Immediately after completing this last description, participants were engaged in a post-experimental interview in order to ascertain whether they adopted specific strategies in describing the extra picture.

Patients ($M = 12.2$, $SD = 8.53$) reported significantly less details than did controls ($M = 52.2$, $SD = 9.47$) when describing the extra picture, $t(18) = -4.07$, $\eta^2 = .48$, $p < .001$. Overall, the results showed no significant differences in the subjective ratings provided by patients and controls in the post-experimental interview.

Question 1: Did you think your description was detailed?

No significant group difference $p = 1$ (Fisher's exact test)

	YES	NO
Patients	80%	20%
Controls	70%	30%

Question 2: Did your description include all the items in the picture?

No significant group difference $p = .656$ (Fisher's exact test)

	YES	NO
Patients	40%	60%
Controls	60%	40%

Question 3: Did you find it was difficult to describe the picture?

No significant group difference $p = 1$ (Fisher's exact test)

	YES	NO
Patients	10%	90%
Controls	0%	100%

Question 4: Did you start by looking at the picture overall to get a general feeling?

No significant group difference $p = 1$ (Fisher's exact test)

	YES	NO
Patients	90%	10%
Controls	100%	0%

Question 5: Did you organize your description a bit before starting it?

No significant group difference $p = 1$ (Fisher's exact test)

	YES	NO
Patients	40%	60%
Controls	40%	60%

Question 6: Did you randomly select a detail to start with?

No significant group difference $p = 1$ (Fisher's exact test)

	YES	NO
Patients	50%	50%
Controls	50%	50%

APPENDIX I

Set materials used in Chapter 6 and 7

List of verbs used in the prospective memory task

All verbs consist in three-syllable words. There is an equal number of verbs in “are”, “ere” and “ire” Italian declensions. Verb in Italics are the target verbs used as prospective memory targets.

- a) Buffer verbs with double consonants: friggere (to fry) scattare (to spring) fuggire (to flee)
- b) Buffer verbs without double consonants: amare (to love) cogliere (to pick) coprire (to cover)
- c) Verbs with double consonants: ballare (to dance), *battere* (to beat); *barrire* (to trumpet), bussare (to knock), correre (to run), leccare (to lick), leggere (to read), mettere (to put), offrire (to offer), russare (to snore), smarrire (to lose), squittire (to squeak), tessere (to weave), toccare (to touch), tossire (to cough)
- d) Verbs without double consonants: *andare* (to go), bandire (to publish), cadere (to fall), cantare (to sing), capire (to understand), credere (to believe), disfare (to unmake), dormire (to sleep), nascere (to be born), partire (to leave), premere (to push), ridare (to return), sentire (to hear), tirare (to pull), togliere (to remove).